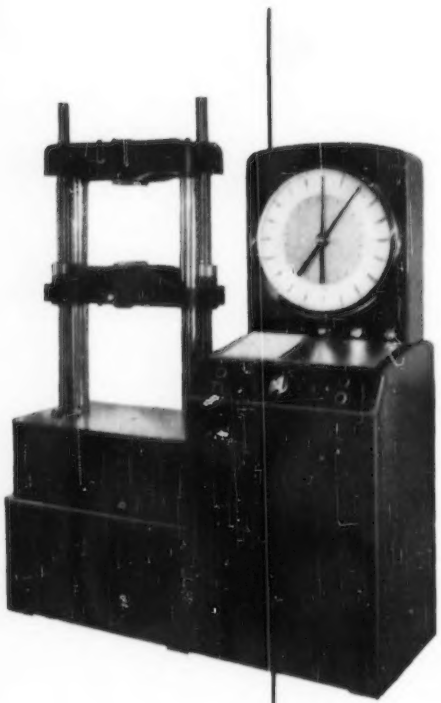
APRIL, 1955
No. 205

# ASTM Bulletin

Advance Outline
58TH ANNUAL MEETING
Atlantic City
June 26—July 3

American Society for Testing Materials

# Can your testing machines pass this "aptitude test"?



(Check box for each "no" answer. If "yes," leave blank.)

| | No | | No |
|---|---|---|---|
| Does my present equipment have infinitely variable speed control? | ☐ | Can it obtain high magnification stress-strain recordings? | ☐ |
| Can it control rate of loading? | ☐ | Does it have unlimited testing stroke over the complete distance between upper crosshead and weighing table? | ☐ |
| Can it control rate of strain? | ☐ | Can it handle off-center loads? | ☐ |
| Can it hold a stress or strain in the elastic range indefinitely? | ☐ | Can it unload as accurately as it loads? | ☐ |
| Can it utilize automatic load holding attachments? | ☐ | Does it have simple controls? | ☐ |
| Is its drive smooth enough not to affect the indicating system? | ☐ | Is its accuracy independent of the operator's skill? | ☐ |

Are you proud of the appearance of your testing equipment? ☐

If your machines rate more than 4 "no" answers, they may be inadequate for today's conditions. Better clip this list and mail to us. Without obligation, we'll be glad to give full information on what you could accomplish with machines that *do* have the features checked. Also check here for Catalog RG-14-55 describing Riehle's complete line of modern testing equipment. ☐

FIRM NAME

ADDRESS

CITY ZONE STATE

ATTENTION MR.

*Mail to:* **RIEHLE TESTING MACHINES**
*Division of American Machine and Metals, Inc., Dept. AS-455, East Moline, Illinois*

Just how well are your present machines suited to modern testing procedures? Many machines now in use are, by today's standards, limited in versatility and convenience — and may be of questionable accuracy.

Here's an easy way to find out if your equipment is doing as complete a job as you could accomplish with up-to-date machines. Simply ask yourself the questions on the check list and determine how your equipment measures up to modern Riehle machines.

This check list also provides a chance to learn the full implications of the features referred to in the questions. Simply check off these features that are lacking in your present equipment. Clip and mail the list now so you'll have the information in your files. No obligation.

*RIEHLE TESTING MACHINES*

*"One test is worth a thousand expert opinions"*

*Division of*
*American Machine and Metals, Inc.*
EAST MOLINE, ILLINOIS

Reg. U. S. Pat. Off.

Raymond E. Hess
*Editor*
George A. Wilson
*Assistant Editor*
Virginia Burkhart
*Editorial Assistant*
John S. Pettibone
*Advertising*

OFFICERS

Board of Directors

*President*
N. L. Mochel

*Vice-Presidents*
C. H. Fellows — R. A. Schatzel

*Directors*

| *Term ending 1955* | *Term ending 1956* |
|---|---|
| G. R. Gohn | N. A. Fowler |
| W. H. Lutz | R. T. Kropf |
| H. K. Nason | T. F. Olt |
| A. O. Schaefer | J. R. Townsend |
| M. A. Swayze | K. B. Woods |

*Term ending 1957*
E. J. Albert
J. M. Campbell
P. V. Garin
J. H. Jenkins
D. E. Parsons

*Past-Presidents*
T. S. Fuller — H. L. Maxwell
L. C. Beard, Jr.

Executive Secretary
R. J. Painter

COMMITTEE ON PAPERS AND PUBLICATIONS

This committee has authority in all matters affecting the acceptance, rejection, editing and publication of papers, committee reports, and discussions. The committee also acts in an advisory capacity to the Board of Directors in publication matters in general.

R. E. Hess, *Chairman*
Robert Burns — S. S. Kurtz, Jr.
T. J. Dolan — F. L. LaQue
L. E. Gregg — M. Van Loo
F. M. Howell — L. W. Wood
L. L. Wyman

*Corresponding Members from Pacific Coast District*
F. J. Converse — R. E. Davis

# ASTM BULLETIN

## APRIL 1955

**Number 205**

**Telephone: Rittenhouse 6-5315** **Cable Address: Testing, Philadelphia**

**Crack Growth Testing: Variation Between Laboratories**—J. M. Buist and G. E. Williams ... 35
**Some Observations on the Mechanics of Alkali-Aggregate Reaction**—L. S. Brown ... 40
Discussion ... 44
**Additional Nomographs for Significance Tests**—Chou Hsiung Li ... 46
**Silicates as Corrosion Inhibitors in Synthetic Detergent Mixtures**—Raymond Getty, Newton W. McCready, and William Stericker ... 50
**Gravitometer for Rapid Density Measurement of Solids**—S. Lipson, A. Saia, and H. Rosenthal ... 60
**The Yield Rate of Mild Steel**—Frederick Forscher ... 63
**Measuring Volume Shrinkage of Resinous Mortars**—Lloyd H. Brown and E. A. Reineck ... 67

### IN THE SOCIETY

**Annual Meeting Advance Outline** ... 5
**ASTM Publications** ... 8
ASTM Standards in Building Codes
Directory of Commercial and College Testing Laboratories
D-9 Compilation
**District Activities**
Chicago, St. Louis, Cincinnati, New York ... 9
New Electronics Committee ... 10
Schedule of ASTM Meetings ... 10
New Work in Hydraulic Fluids ... 10
Presentation of Technical Papers ... 11
ACR Notes ... 12
**Technical Committee Notes** ... 13
**Proposed Specification for Packaged, Dry, Combined Materials for Mortar and Concrete** 28
Method for Determining the Squareness of Charpy V-Notch Test Specimen and Other Square or Parallel Bars—S. E. Siemen ... 34
Personals ... 72
New Members ... 78
Deaths ... 82

### GENERAL NEWS NOTES

Engineering Foundation ... 30
Random Samples ... 32
The Bookshelf ... 69
Other Societies' Meetings ... 84
News of Laboratory Supplies and Equipment ... 86
Index to Advertisers ... 94

ASTM Bulletin is indexed regularly by Engineering Index, Inc.

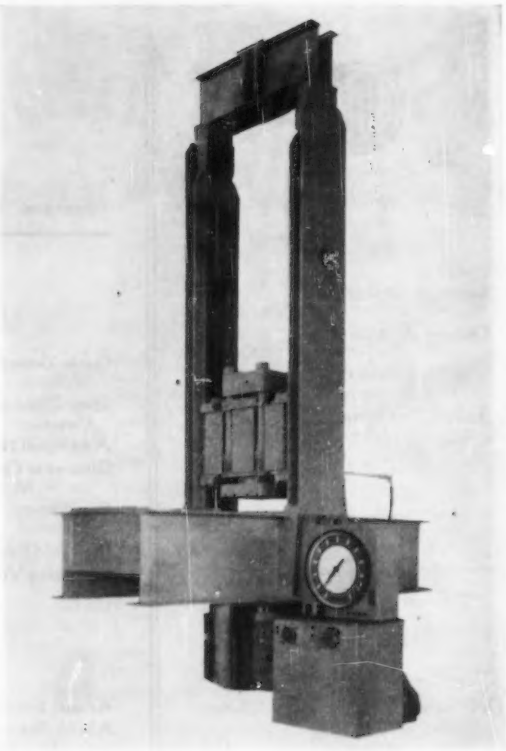
The Society is not responsible, as a body, for the statements and opinions advanced in this publication.

ASTM Bulletin, April 1955. Published eight times a year, January, February, April, May, July, September, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 1916 Race St., Philadelphia 3, Pa. Subscriptions, United States and possessions, one year, $2.75, two years, $4.75, three years, $6.50; Canada, one year $3.25; two years $5.75; three years, $8.00. Other countries, one year, $3.75; two years, $6.75; three years, $9.50. Single copies—50 cents. Number 205. Entered as second class matter, April 8, 1940, at the post office at Easton, Pa., under the act of March 3, 1879.
Copyrighted 1955, by the American Society for Testing Materials.

# TESTING

PICTURE OF THE MONTH—

THIS MASSIVE 600,000 LB UNIVERSAL TESTING MACHINE WAS RECENTLY INSTALLED IN A LARGE EASTERN AIRCRAFT LABORATORY. IT IS DESIGNED SPECIFICALLY FOR AIRCRAFT TESTING AND WILL ACCOMMODATE SPECIMENS UP TO 20′ LONG BY 10′ HIGH.

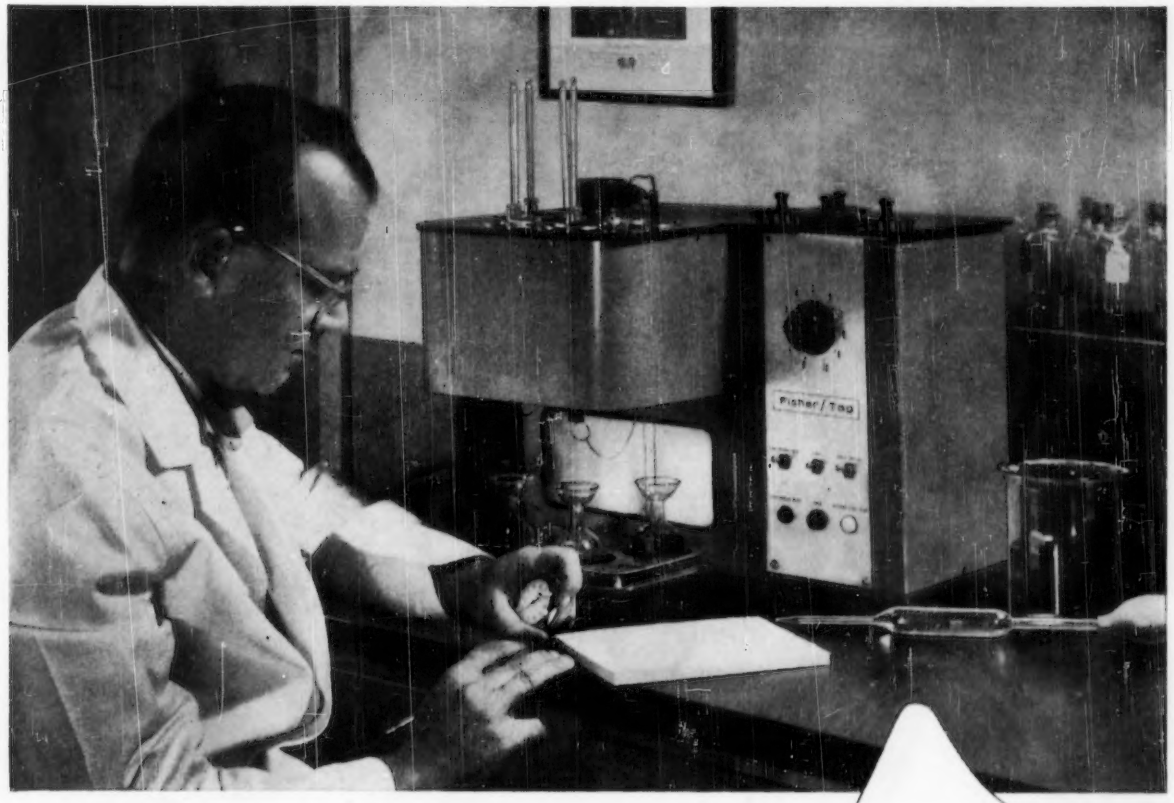


| | |
|---|---|
| **Tension, Compression, Traverse, Fatique—** | Young Universal Testing Machines cover a range of 1,000 lbs to 5,000,000 mechanically or hydraulically driven complete with all accessories. Machines for Torsion-Creep and Box testing. |
| **Thrust Photo-Elastic** | Young Thrust-Load Weighing Systems are available in pneumatic, hydraulic, or electrical models. Also color testing units. Photo-elastic machines with 8″ light fields. |
| **Strain Gages, Bond Checkers—** | Young New Strain Indicators. Static and hi-speed switching units up to 200 gages per sec. X-Y Recorders—1 to 48 channels. Oscillograph amplifiers. Bond Checkers—check your gage application in 10 sec. |
| **Paper Processor, Film Processor—** | Young Processors automatically develop and dry up to 12″ wide oscillograph paper—with built-in leader. Young Film Processor for developing and drying 16-35-70 mm—fully automatic. Price $2970. |
| **Recording Instruments** | World-Famous Kelvin Hughes Electronic-Hi-Speed Pen Recorder—1 channel $795. 4 channel $995. Huggenberger Extensometers from Switzerland. Hi-speed and Flight Cameras. |

Here is the finest in testing priced to meet your budget. Based on years of specialized design and production of test equipment, Young offers you a versatility and knowledge that can solve your testing problems at minimum cost. If a standard machine is not the most economical answer, you'll find our engineers glad to design a machine that is. A letterhead request brings details . . . . write today.

## Young Testing Machine Co.

**(Phone) NORRISTOWN 8-8889**
**Box 233-A Bridgeport, Penna.**




# More Reliable Viscosity Measurements

## *with improved, easy-to-use*

## FISHER/TAG SAYBOLT VISCOSIMETER

The Fisher/Tag Saybolt Viscosimeter is completely redesigned and greatly improved. It is compact, more efficient, easier-to-use, completely reliable . . . and is designed to meet ASTM specifications.

The key to its reliability is its ability to hold oil samples within .02°F. (.01°C) at temperatures ranging between 60° and 220°F (15.5-104.4°C). Fisher achieves this with a completely new thermostated circulating bath encasing the standard Saybolt tubes.

The bath is made of corrosion-resistant stainless steel, spot-welded and soldered to assure leakproof construction. A drain-overflow holds the level of the bath liquid at the prescribed height on the Saybolt tubes. The bath can be drained conveniently through external connections.

**FISHER SCIENTIFIC**

| | | | |
|---|---|---|---|
| Boston | Cleveland | Philadelphia | Washington |
| Buffalo | Detroit | Pittsburgh | Montreal |
| Chicago | New York | St. Louis | Toronto |

America's Largest Manufacturer-Distributor of Laboratory Appliances and Reagent Chemicals

FISHER SCIENTIFIC CO.
717 Forbes St., Pittsburgh 19, Pa.

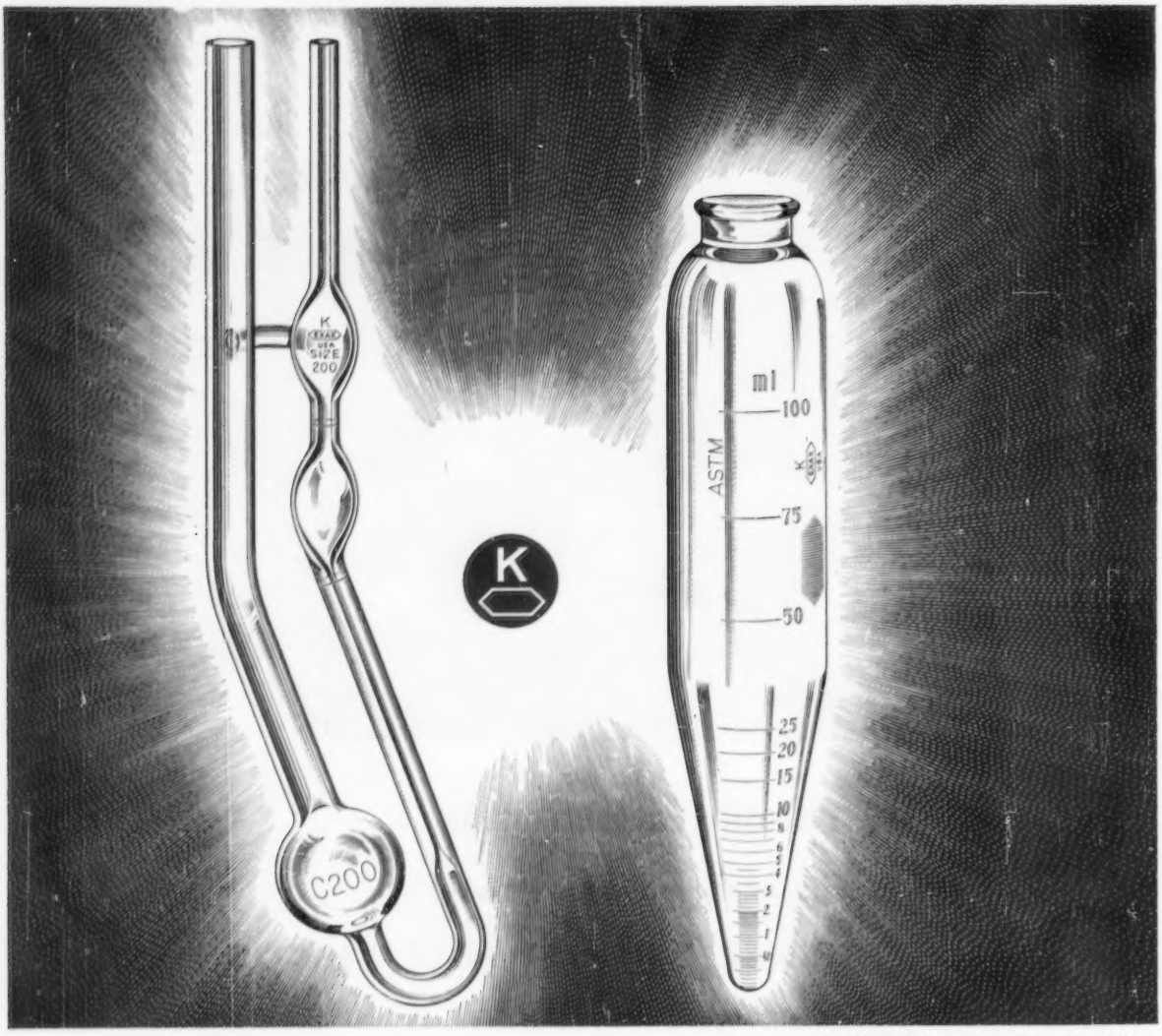
Please send me Booklet FS-209-F which describes Fisher/Tag Saybolt Viscosimeter and other petroleum testing equipment.

Name_____ Title_____

Company_____

Street_____

City_____ Zone____ State_____




*Kimble Oil Centrifuge Tube No. 45240;*
*Kimble Viscosimeter Tube No. 46460*

# ACCURATE!

## KIMBLE Oil Centrifuge and Viscosimeter Tubes

**If your work demands accuracy, demand Kimble Glassware**

All Kimble Oil Centrifuge Tubes and Viscosimeter Tubes comply with ASTM requirements for accuracy and design.

**Kimble Oil Centrifuge Tubes** have sturdy uniform walls which readily withstand the mechanical stresses encountered at test speeds. The Tubes have uniform neck openings. The colored filler which is fused into the graduation lines and numbers is permanent. Graduation lines are fine and sharp to permit easy, quick reading. Every Kimble Oil Centrifuge Tube is *individually recalibrated.*

**Kimble Viscosimeter Tubes** are sturdily made to withstand mechanical abuse. All seals are smooth to provide flow without undue turbulence. Serial numbers are provided with separate series for the different sizes to help prevent errors. The filler in the graduation lines and numbers is permanent.

All Kimble tubes are thoroughly annealed to increase mechanical strength.

There is a Kimble glassware item available to fill every laboratory requirement. Ask your laboratory supply dealer for what you need, or write Kimble Glass Company, subsidiary of Owens-Illinois, Toledo 1, Ohio.

KIMBLE LABORATORY GLASSWARE
AN (O) PRODUCT

OWENS-ILLINOIS
GENERAL OFFICES • TOLEDO 1, OHIO

# ASTM BULLETIN

*"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"*

Number 205 APRIL, 1955


## Advance Outline—58th Annual Meeting Atlantic City, N. J., June 26—July 1

PREPARATION of an advance outline of the sessions and committee meetings for the Annual Meeting was so well received last year that we are again presenting this information on the 1955 Annual Meeting. It should be emphasized, however, that the information is tentative, particularly with regard to committee meetings. These have been scheduled to make most efficient use of the meeting rooms available in Atlantic City and to avoid the necessity of using some of the larger rooms for more than one meeting at a time.

This outline of the meeting should be helpful to members in making their preliminary plans for attending the meeting. Final plans for attending committee meetings at the Annual Meeting definitely should be based on notices received from the chairmen or secretaries of the committees involved.

### Headquarters Hotel

All the technical sessions will be held in Chalfonte-Haddon Hall. Unless it is necessary to rearrange the present schedule of committee meetings, all committee meetings will be held at Chalfonte-Haddon Hall. In view of the close scheduling necessary to hold over 600 technical committee meetings and some 35 technical sessions in four and one-half days, there is a great advantage in being able to confine the meetings to one location. Sleeping accommodations have been secured from Chalfonte-Haddon Hall, Hotel Lafayette, Colton Manor, Seaside, Senator, and Morton hotels. These cooperating hotels have provided excellent accommodations for our members in past years in Atlantic City.

### Hotel Reservation Forms

About April 10 the official hotel reservation form together with a preliminary outline of all sessions and committee meetings will be sent to all members and committee members. By this time the various committees will have approved their meeting schedule. It is highly recommended that our members wait until they receive the hotel reservation form before writing for their accommodations. It is impossible to make the fullest use of the available sleeping room facilities when reservations are made too far in advance and have to be canceled or changed.

### Entertainment

Once again the Philadelphia District Council will act as hosts for the Atlantic City Annual Meeting, an assurance that a very interesting entertainment program will be prepared, particularly for the ladies attending the meeting. The same type of entertainment provided at previous meetings in Atlantic City is being planned this year.

### Advance Outline of Program

#### Technical Sessions

The attached table outlines the various technical sessions that will be held throughout the week. It should be noted that at 11:30 a.m. and 4:30 p.m. short sessions are planned for the presentation of committee reports. A complete Provisional Program, including abstracts of all technical papers, will appear in the May BULLETIN which will go in the mails early in May. The fol-

### ADVANCE TENTATIVE OUTLINE OF FIFTY-EIGHTH ANNUAL MEETING

| | MONDAY, June 27 | TUESDAY, June 28 | WEDNESDAY, June 29 | THURSDAY, June 30 | FRIDAY, July 1 |
|---|---|---|---|---|---|
| Morning | Opening Session — Symposium on Impact | Session on Non-Ferrous Metals | Sym. on Corrosion<br>Session on Concrete (C-9 Report) | Panel on Pyrometry<br>Session on Fatigue | Session on Fatigue<br>Session on Testing |
| | 11:30 a.m.<br>Report Session | 11:30 a.m.<br>Report Session | 11:30 a.m.<br>Report Session | 11:30 a.m.<br>Report Session | 11:30 a.m.<br>Report Session |
| Afternoon | Sym. on Impact<br>Session on Soils | 12:00 noon<br>Luncheon Session — President's Address, Awards | Sym. on Corrosion<br>Sym. on Speed of Testing | Sym. on Metallic Materials for Service Above 1600 F | 1:30 p.m.<br>Session on Fatigue (E-9 Report) |
| | | Session on Steel | | | |
| | 4:30 p.m.<br>Report Session | 5 p.m.<br>Gillett Lecture — Fritz V. Lenel — Metal Powder | 4:30 p.m.<br>Marburg Lecture — W. J. Hamburger — Textile Fibers | 4:30 p.m.<br>Report Session | |
| Evening | Sym. on Judgment of Soils Testing<br>Session on Testing | Sym. on Sig. of Tests of Concrete<br>Sym. on High Purity Water Corrosion | Cocktail Party<br>ASTM DINNER<br>Floor Show<br>Dancing | Sym. on Metallic Materials for Service Above 1600 F | |

**Aerial View of Section of Atlantic City, Showing Location of Headquarters and Cooperating Hotels.**

1. Haddon Hall
2. Chalfonte
3. Senator
4. Lafayette
5. Colton Manor
6. Morton
7. Seaside

lowing symposiums will feature the technical sessions.

Impact Testing (Monday morning and afternoon)
Judgment Factors in Soil Testing (Monday evening)
Significance of Tests of Concrete (Tuesday evening)
High Purity Water Corrosion (Tuesday evening)
Speed of Testing of Non-Metallic Materials (Tuesday evening and Wednesday afternoon)
Atmospheric Corrosion of Non-Ferrous Metals (Wednesday morning and afternoon)
Metallic Materials for Service at Temperatures above 1600 F (Thursday afternoon and evening)

## Luncheons, Lectures and Dinners

### President's Luncheon (Tuesday Noon)

The President's luncheon will again provide the occasion for the President's Address and the presentation of various recognitions and awards. Holding this event at a luncheon session has worked out most successfully in enabling our busy members to attend.

### Gillett Lecture (Tuesday afternoon)

The fourth H. W. Gillett Memorial Lecture on the subject Metal Powders and Compacts will be presented by Fritz V. Lenel of the Department of Metallurgical Engineering, Rensselaer Polytechnic Inst.

This lecture—first presented at the Fiftieth Anniversary Meeting of the ASTM in 1952—is jointly sponsored by the American Society for Testing Materials and Battelle Memorial Inst. and commemorates Horace W. Gillett, the first Director of Battelle, and one of America's leading technologists and metallurgists. Its scope covers subjects pertaining to the development, testing, evaluation, and application of metals.

### Marburg Lecture (Wednesday afternoon)

W. J. Hamburger, Director of Fabric Research Laboratories, Boston, Mass. will present the twenty-ninth Edgar Marburg Lecture, on the subject of the properties of textile fibers.

This lecture originated as a memorial to the first Secretary of the Society and was established to emphasize the importance of furthering knowledge of properties and tests of engineering materials.

### ASTM Annual Dinner (Wednesday evening)

The Philadelphia District Council is again including in its plans the usual ASTM Dinner with entertainment and dancing. An informal "dutch treat" cocktail party will precede the dinner. This ASTM annual dinner, providing an opportunity for our members to meet socially in the midst of a busy week of meetings, has become one of the principal events on the entertainment schedule. Complete details of the dinner and other entertainment features will be outlined in the May BULLETIN.

**Report Sessions**

As mentioned above, provision is made in the morning and afternoon of each day for Report Sessions where committees can present their reports to the Society following their committee meeting. The committee reports to be presented at each of the sessions will be outlined in the table which will accompany the hotel reservation form and will also appear in the Provisional Program in the May BULLETIN.

## Committee Meetings

All of the committees which have indicated that they will meet during the Annual Meeting of the Society are now being canvassed for confirmation of the days when they will meet. The following committees have indicated their intention to meet. Beside each committee we are indicating in parentheses the meeting time being suggested to each committee. (It should be remembered that official notice of committee meetings will come from the officers of each committee and that final plans for attending these meetings should be made in accordance with advice received directly from them.) The table accompanying the hotel reservation form, which will go in the mails around April 10, will show a tentative plan of committee meetings, and will indicate in which hotel each meeting will be held.

**A-1 on Steel**—Monday, Tuesday Wednesday
**A-2 on Wrought Iron**—MAIN—Thursday
**A-3 on Cast Iron**—Thursday, Friday
**A-5 on Corrosion of Iron and Steel**—Monday, Tuesday
**A-6 on Magnetic Properties**—Tuesday
**A-7 on Malleable-Iron Castings**—Wednesday
**A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys**—Tuesday, Wednesday
**B-2 on Non-Ferrous Metals and Alloys**—Monday, Tuesday
**B-3 on Corrosion of Non-Ferrous Metals and Alloys**—Thursday, Friday
**B-4 on Metals for Electrical Heating, Electrical Resistance, and Electronic Applications**—Monday and Tuesday
**B-6 on Die-Cast Metals and Alloys**—Tuesday, Wednesday
**B-7 on Light Metals and Alloys, Cast and Wrought**—Wednesday, Thursday
**C-1 on Cement**—Wednesday, Thursday
**C-2 on Magnesium Oxychloride Cement**—Tuesday
**C-3 on Chemical-Resistant Mortars**—Tuesday, Wednesday
**C-4 on Clay Pipe**—Monday, Tuesday
**C-7 on Lime**—Thursday, Friday
**C-9 on Concrete and Concrete Aggregates**—Monday, Tuesday
**C-11 on Gypsum**—Tuesday
**C-12 on Mortars for Unit Masonry**—Wednesday, Thursday
**C-15 on Manufactured Masonry Units**—Thursday, Friday
**D-1 on Paint, Varnish, Lacquer, and Related Products**—Monday, Tuesday, Wednesday
**D-2 on Petroleum Products and Lubricants**—Sunday to Friday
**D-4 on Road and Paving Materials**—Wednesday, Thursday
**D-5 on Coal and Coke**—Sunday to Thursday
**D-6 on Paper and Paper Products**—Thursday, Friday
**D-8 on Bituminous Waterproofing and Roofing Materials**—Monday, Tuesday
**D-9 on Electrical Insulating Materials**—Monday, Tuesday, Wednesday
**D-11 on Rubber and Rubber-Like Materials**—Wednesday, Thursday, Friday
**D-13 on Textile Materials**—(ADV. & SUBS)—Wednesday
**D-16 on Industrial Aromatic Hydrocarbons and Related Materials**—Monday, Tuesday
**D-17 on Naval Stores**—Monday, Tuesday
**D-18 on Soils for Engineering Purposes**—Monday, Tuesday
**D-19 on Industrial Water**—Wednesday, Thursday, Friday
**D-20 on Plastics**—Wednesday, Thursday, Friday
**E-1 on Methods of Testing**—SUBS—Monday, Tuesday, Wednesday, Thursday
**E-2 on Emission Spectroscopy**—Tuesday, Wednesday, Thursday
**E-3 on Chemical Analysis of Metals**—Sunday, Monday, Tuesday, Wednesday
**E-4 on Metallography**—Thursday, Friday
**E-5 on Fire Tests of Materials and Construction**—Monday, Tuesday
**E-6 on Methods of Testing Building Constructions**—MAIN—Wednesday
**E-7 on Non-Destructive Testing**—Monday, Tuesday
**E-9 on Fatigue**—MAIN—Thursday
**E-10 on Radioactive Isotopes**—Tuesday
**E-12 on Appearance**—Monday
**Adm. District Act.**—Tuesday, Wednesday Breakfast
**Jt. Eff. of Temp.**—Wednesday, Thursday, Friday

# 1955 Metal Powder Meeting to Feature Electronic Core Session

AGAIN this year, as it has for the past eleven years, the Metal Powder Assn will sponsor a National Meeting and Show devoted solely to powder metallurgy, the metal powder industry, and the arts and sciences based on metal powders. This year, for the first time, the event will take place in Philadelphia May 10, 11, 12 at the Bellevue-Stratford Hotel.

Technical sessions at the Eleventh Annual Meeting are divided into (1) a General Session devoted to papers relating to a variety of aspects of powder metallurgy, and (2) an Electronic Core Session consisting of a separate meeting on subjects of interest to those in the electronics field. The General Session will begin on Wednesday, May 11, and the program will include the following:

**Machinability of Sintered Bronze,** by W. A. Irvine, The Maytag Co.
**Finishing and Plating of Metal Powder Parts,** by C. C. Cohn, Colonial Alloys Co.
**Prealloyed Steel Powders and Application,** by G. A. Roberts and A. Grobe, Vanadium-Alloys Steel Co.
**Carbide Tooling for Pressing Metal Powders,** by T. A. Wilson, National Carbide Die Co.
**The Iron Powder Industry in Europe—Present and Future,** by S. I. Hulthén, Hoeganaes Billesholms Aktiebolag.
**The Economic Production of Metal Powder Parts in Small Volume,** by B. I. Horton, Pitney-Bowes, Inc.
**A Powder Producer Looks at Titanium Powder Metallurgy,** by J. F. Sachse, Metals Disintegrating Co., Inc.
**A Fabricator Looks at Titanium Powder Metallurgy,** by H. W. Dodds, The Brush Laboratories Co.

The Electronic Core Session, running concurrently will include:

**Trends in Ferrite Core Design for TV Yokes and Flybacks,** by C. E. Torsch, The Rola Co.
**Antenna Cores,** by C. A. Grimmett, General Electric Co.
**Application of Ferrites to Memory Systems,** by W. N. Papian, Mass. Inst. of Tech., Lincoln Lab.
**The Various Iron Powders Used in Electronic Cores,** by J. A. Roberts, Antara Chemicals, Div. General Aniline & Film Corp.
**Some Results of the Evaluation Program for Iron Powdered Cores,** by E. Both, Squier Signal Lab., Signal Corps Eng. Lab.
**Method of Specifying Iron Cores,** by C. E. Cherry, Jr., Metal Powder Association.
**Panel on Threaded Cores.** Moderator: R. D. Ponemon, Pyroferric Co., Inc.

The 1955 Metal Powder Show opens on Tuesday, May 10.

# NEW ASTM PUBLICATIONS

## ASTM Standards in Building Codes

THIS compilation brings together more than 250 ASTM specifications, methods of test, and definitions of materials included by reference in the major building codes of the United States and Canada. Due to the wide variety of materials covered and the many technical committees concerned, these standards previously have been scattered throughout the 10,000-page seven-part Book of ASTM Standards. Although available as separates, the selection and accumulation of individual standards needed has been an uncertain means of securing the entire group. Realizing the need and utility of a special compilation of these ASTM Standards, this first edition has now been prepared.

The compilation is designed for the use of building code authorities so that they can maintain in simple form in their files and libraries a complete set of applicable ASTM Standards for instant reference at all times, and for facilitating building code revisions. This publication will also be of great value to architects, engineers, and contractors in the building construction field.

It is planned to compile needed supplements each year similar to those prepared for the Book of Standards in which will be found all revisions and additions for that year. Complete new editions of the compilation will be issued when warranted.

The standards in this compilation cover the full range of construction materials including structural and reinforcing steel; steel, cast iron, and copper pipe; building units; bituminous roofing; cement; gypsum; ready-mixed concrete; and many other materials.

This 950-page compilation bound in heavy paper covers can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price: $6; to members, $4.50.

• • •

## Directory of Commercial and College Testing Laboratories

THIS Directory is a successor to the Directory of Commercial and College Laboratories published in 1947 by the U. S. Department of Commerce, National Bureau of Standards, as Miscellaneous Publication M 187. Responsibility for its compilation and publication has been transferred from the National Bureau of Standards to the American Society for Testing Materials by agreement between the two organizations.

The Directory lists the locations of testing laboratories equipped and prepared to undertake testing on a commercial or fee basis. The data indicating the nature of tests and the types of commodities tested have been collected on the basis of signed statements from responsible officers of the laboratories listed.

Information is given concerning 278 commercial testing laboratories and their 151 branches or offices. There is also presented a list of the laboratories of 86 colleges that are prepared to do testing under certain conditions. Research and consulting laboratories are not listed unless they also are engaged in testing on a commercial basis.

The Directory is designed to be of assistance to purchasers not equipped to make their own tests, and who therefore have hesitated to buy on specifications. The knowledge that they can at any time call on testing laboratories to check deliveries made to them on specifications should induce many purchasers to take full advantage of the specification method of buying. It will also be of value to small manufacturers and others seeking testing laboratory services.

Although the Directory has been compiled from the viewpoint of the testing of commodities, the classification has been expanded to include a few items not strictly commodities, but which are becoming increasingly important in the fields of manufacturing, construction, and sanitation; for example, air (pollution), industrial water and wastes, and building constructions.

It is designed to give maximum information in minimum space. It will give the user a good indication of the laboratories most likely to be prepared to undertake the tests desired. It does not pinpoint every possible test within the many laboratories, but when used as the guide it is intended to be, the user can readily select the near-by laboratories which will most likely be able to fulfill his testing needs.

Heavy paper cover, 8 by 10½ in.; 48 pp. Price: $1; to ASTM members, 75 cents.

• • •

## Standards on Electrical Insulating Materials

THIS latest edition of the compilation of ASTM Standards and Data on Electrical Insulating Materials makes available in convenient reference form all the standards, specifications, and methods of tests in the province of ASTM Committee D-9.

The 95 standards cover insulating varnishes, paints, lacquers; molded materials; plates, sheets, tubes, and rods; mineral oils; ceramic products; solid filling and treating compounds; electrical tests, insulating papers; mica, rubber; textiles, conditioning etc.

Copies of this 652-page compilation bound in heavy paper covers can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price: $5.50; to members, $4.25.

• • •

### Reprint Prices Advanced

**Effective February 1, 1955, our schedule of prices for separate reprints of ASTM Standards was revised as follows:**

**In Lots* of 1 to 9:**

1 to 16 pages—30 cents each.
17 to 32 pages—50 cents each.
Over 32 pages†—60 cents each.

**Quantity Prices:**

10 to 24—10 per cent discount from above prices.
25 to 100—15 per cent discount from above prices.
100 and over—special quotation.

* Lots may consist of the same or assorted standards.
† Or with insert plates.

# District Activities

## President Mochel Addresses Joint Meetings in Chicago, St. Louis, and Cincinnati

As a prelude to their Western trip which will be reported in the May Bulletin, President Mochel and Executive Secretary Painter visited the Chicago District on January 24, the St. Louis District on January 25, and the Ohio Valley District on February 2.

### Chicago

The meeting in Chicago, held at the Western Society of Engineers and sponsored jointly with that group, was held during what appeared to be the start of a blizzard. Although the streets were reasonably clear by the time the meeting had ended, the snow and slippery conditions during the afternoon were sufficient to cut the attendance to 75 for the technical session, with 40 members and guests of ASTM and WSE present at dinner.

H. P. Hagedorn, Chairman of the ASTM Chicago District Council, presided at the meeting and introduced Executive Secretary Painter who spoke briefly on "Cooperation in Materials Research and Standards." Mr. Painter stressed the interrelations of ASTM with other technical and trade associations, pointing out that the desirability of such cooperation is reflected in the 260 such groups now represented on technical committees of the Society. One hundred sixty of these groups hold Society membership. In addition, Mr. Painter pointed out the apparent current trend of industry not to be interested in students specializing in materials, but more interested in engineering physicists. His final comment reaffirmed the observation made many times before that research and standardization go hand in hand.

A. Allan Bates, Vice-President of Research and Development, Portland Cement Assn., and Chairman of the General Committee on Arrangements for the Annual Meeting held last year in Chicago, expressed pleasure in being asked to introduce President Mochel. Dr. Bates commented that he had known President Mochel for many years, having been directly associated with him for ten years at Westinghouse.

President Mochel's address, "Power and Materials, Now and in the Future—Some Metals and Materials Problems," was well received as it has been elsewhere. The President has adapted his talk in the various districts in which he has spoken to include references to installations in the area. His reference to the installations in many of our large naval vessels as well as the U.S.S. *United States* was also of interest to many of those present as only a few were familiar with these particular turbines. Discussion of his talk prompted additional comments concerning aspects in the use of nuclear energy.

### St. Louis

The January 25 meeting was cosponsored by the ASTM St. Louis District and the St. Louis Chapter of the Missouri Society of Professional Engineers. The meeting was held in the Crystal Room of the Athletic Club and was preceded by a well-attended dinner. Possibly 125 attended the technical session. In appreciation of their services, Messrs. Mochel and Painter were awarded Certificates of Appreciation by Chapter President W. P. Rathell, on behalf of the Missouri Society of Professional Engineers. Messrs. J. M. Wendling, Chairman, W. C. Magruder, Vice-Chairman, and J. R. Romig, Secretary, of the ASTM District, were present.

### Cincinnati

Although there was no attempt to sponsor a meeting during Committee Week on a Society-wide basis, the Ohio Valley District thought this to be timely for the appearance of President Mochel in that area and accordingly cosponsored with the ASM Cincinnati Chapter the joint meeting on February 2. There were more than 70 present for a dinner and approximately 100 for the technical session. J. C. Pitzer of the Formica Co., Chairman of the ASTM Ohio Valley District, acting as program chairman, introduced President Mochel. Prior to Mr. Mochel's address, Mr. Pitzer called on Executive Secretary Painter for a few words. Mr. Mochel's address was well received with the interest as usual focused on the aspects of the use of nuclear energy.

### NEW YORK

"The New Patent Act as It Affects Engineers" was the topic discussed by Norman N. Holland, President, New York Patent Law Association, at the joint meeting of the ASTM New York District and the New York Chapter, N. Y. State Society of Professional Engineers at the Hotel Statler, January 24, 1955. Mr. Holland outlined the more important changes made in the new patent law, including the granting of patents for new uses, and discussed provisions concerning the protection of inventions and tax treatment of royalties which was of direct interest to engineers. The extensive period of questions which followed Mr. Holland's presentation indicated the intense interest of the group in this subject. About 150 members of the two societies gathered at 6:30 to hear Mr. Holland. Welcoming remarks were made by the officers of the local sections of the two societies, and introductions of past officers were made. ASTM Past President, L. C. Beard, Jr. (a college classmate of Mr. Holland), was present.

The excellent program was arranged largely through the efforts of Harold Carlson, representing ASTM, and Howard Podell, representing NYSSPE. ASTM Headquarters was represented at the meeting by Assistant Secretary Fred F. Van Atta.


**We Will Buy—**

**YOUR PART 1, 1952 BOOK OF ASTM STANDARDS**

**A large demand for Part 1 of the 1952 Book of ASTM Standards has nearly exhausted our stock. If your copy is in reasonable condition for resale we will buy it back at $4 upon its receipt at ASTM Headquarters. Be sure a return address is on the package to enable identification, and, better still, advise that shipment is being made.**

ASTM Bulletin

APRIL 1955

NO. 205

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

## New Electronics Committee

THE Board of Directors now has under consideration the establishment of a new committee on Materials for Electronic Devices to be formed from a nucleus consisting of Subcommittee VIII on Metallic Materials for Radio Tubes and Incandescent Lamps of Committee B-4 on Metals for Electrical Heating, Electrical Resistance, and Electronic Applications. The recommendation to form such a committee was formally voted at a meeting of Committee B-4 held in January, 1955.

The subject of electronics is assuming ever increasing importance and significance and would seem to justify having the standardization work handled in a committee devoted solely to this purpose. While no precise scope has as yet been outlined, the committee would probably include test methods and specifications for materials which go into the making of electron tubes. Examples are cathodes, grid wires, plate materials, glass to metal seals, mica stampings, and special ceramic insulators. The scope may also include phosphors for fluorescent lamps and cathode ray tubes.

Two committees on organization have been appointed to submit recommendations covering the scope and personnel of this proposed new committee as well as for the continuation of the work of Committee B-4. The committee on organization of the new committee is composed of A. M. Bounds, *chairman*, Superior Tube Co.; Frank J. Biondi, Bell Telephone Laboratories; and D. R. Kerstetter, and C. M. Harman, Sylvania Electric Products, Inc.

The organization committee for the work of Committee B-4 include: J. D. Kleis, *chairman*, Fansteel Metallurgical Corp.; C. W. Armstrong, C. O. Jelliff Co.; P. H. Brace, Westinghouse Electric Corp.; and E. Edmunds, Driver-Harris Co.

## Schedule of ASTM Meetings

**This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.**

| DATE | GROUP | PLACE |
|---|---|---|
| April 15 | Joint Committee on Chemical Analysis by Powder Diffraction Methods | Brooklyn, N. Y. (Polytechnic Inst.) |
| April 21–22 | Committee D-10 on Shipping Containers | Madison, Wis. (Forest Prod. Lab.) |
| April 25 | Committee C-21 on Ceramic Whiteware and Similar Products | Cincinnati, O. (Netherland Plaza) |
| April 27–28 | Committee C-19 on Structural Sandwich Constructions | Madison, Wis. (Forest Prod. Lab.) |
| May 17 | Committee E-11 on Quality Control | Philadelphia, Pa. (Society Headquarters) |
| May 22–27 | Committee E-14 on Mass Spectrometry | San Francisco, Calif. (Mark Hopkins) |
| **June 26–July 1** | **ASTM Annual Meeting** | **Atlantic City, N. J (Chalfonte-Haddon Hall)** |

## New Work in Hydraulic Fluids?

USE of hydraulic fluids as an engineering material received great impetus during World War II, in the transfer of power to even the remotest points in military aircraft, warships, and ordnance. Simple fluids for these applications were early ruled out since the fluids are expected not only to supply power but lubrication and undiminished properties at temperature extremes.

During the war, the Federal Government published specifications for certain types of hydraulic fluids for military aircraft and ordnance use. Some fluids are extremely hazardous in military aircraft, and experimentation began early on nonflammable hydraulic fluids which could meet the rigorous demands of military use.

Since the war, test methods for hydraulic fluids have been standardized by several automotive organizations for use as brake fluids and as automatic transmission fluids. Nonflammable hydraulic fluids have been developed for use in hazardous systems, but the test methods applicable to these special fluids having a variety of applications are as yet not standardized.

Lately the Society has been asked to initiate a program of standardization of test methods in the safety hydraulic fluid field. The Board of Directors and the Society Headquarters Staff is seeking information concerning the need of standardization in this field to determine if such a program should be set up. It will be appreciated if those interested in this field will send their comments to the Society and also inform any others concerning the Society's interests in this direction.

# Toward Better Presentation of Technical Papers

## Papers Committee Continues Plan to Improve Listener Interest

IT IS expected that any scientist, by ability or training or both, should be able to communicate his thoughts to his fellows through effective presentation of the spoken word, as well as the written. Already many of our scientists and engineers have realized the value of employing a little salesmanship, showmanship, histrionics—call it what you will—in order to explain successfully what they have been doing. They have found that, in these times of inevitable technical specialties bred by expanding science and engineering, an audience made up of even their own associates is often not entirely familiar with the particular specialties being described by the speaker. Time spent in improving their ability to convey an idea or concept, they find, is a good technical investment.

Here in ASTM, our own Papers Committee is selfishly interested in this matter from the point of view of improving the interest of the technical sessions by improving the character of presentations of technical papers. First of all they tried out a plan for appraising the presentations. The problem of equitably judging the many presentations to be made in so many sessions is admittedly quite formidable. Obviously the members of the Papers Committee, with their other individual commitments, cannot hear all papers—particularly when there may be many simultaneous sessions. The assembly, training, and assignment of an adequate panel of judges also seemed too laborious and unwieldy to be workable. A way out of this impasse was to supplement the Papers Committee with reporters—rather than judges—each of the latter being asked to fill out a standard report card on the presentations which he hears. The committee has worked up a standard sheet of items usually associated with effective presentation which is used in gathering data for further study. The check list is sent in advance to authors who plan to present papers at the meeting.

### Confidential Report Card

The accompanying report card lists systematically a number of characteristics of speakers and paper presentations. With check marks a reporter can give a comprehensive, objective statement of

**Timing**

started_____m. well timed_____
stopped_____m. too long _____
time_____min. too short _____

**Organization**

gave suitable introduction: yes____ no____
topics discussed in logical order: yes____ no____
interrelationships of topics: made clear _____
fairly clear _____
obscured _____
closed effectively_____ or just ran down_____

**Manner**

presented paper by: talking without notes_____
talking from manuscript or notes_____
reading manuscript_____
commenting on visual aids_____
looked at audience: all of the time _____
part of the time _____
never _____
effort to gain audience attention: enthusiastic _____
casual _____
complacent _____
mannerisms:
relaxed or moved easily____ clutched lectern ____
stood rigidly ____ hands in pockets ____
moved excessively ____ nervous efforts ____
gestures:
impressive _____
natural _____
distracting _____
none _____

**Speech**

enunciation:
distinct _____ heard by all _____
fairly distinct _____ partially heard _____
indistinct _____ seldom heard _____
phraseology:
concise _____ descriptive _____
brief _____ generalized _____
verbose _____ vague _____
used extraneous transitions ("er," "ah," etc.) yes____
no ____
delivery:
smooth ____ appropriate emphasis ____
deliberate ____ periodic inflection ____
jerky ____ monotone ____

**Visual Aids**

quantity: too many____ too few____ adequate____
quality:
well composed ____ vivid ____
superfluous detail ____ legible ____
confusing ____ illegible ____
presented: too fast____ too slow____ suitably____
visual aids (would have been) (were) helpful____ if
hinderance____ to the presentation

**Discussion-Rebuttal**

attitude toward questions: replies:
receptive ____ logical and convincing ____
indifferent ____ acceptable ____
antagonistic ____ evasive ____
irrelevant ____
no discussion held____

**General**

Have you a clear idea of the speaker's theme? yes____ no____
Was he convincing to you? yes____ no____
Did he hold the attention of the audience? yes____ no____
Was this an exceptionally good presentation? yes____ no____
Comment:_____

what a speaker does. He does not have to compare speakers nor assess how good or how poor are their efforts. He may offer such opinions if he wishes, but the standard report is all that is required.

Just before he opens the session, the chairman selects three persons in the audience, supplies each with a packet of report cards, and asks them to serve as reporters. At the end of each session the reporters give their sets of report cards to the session secretary, to be held for appraisal by the Papers Committee.

Any author may write to the chairman of the Papers Committee after the Annual Meeting and obtain his check sheet if he is interested.

**Comment Welcomed**

It is hoped that refinements and improvements in the original system can be made. The comments and suggestions of sessions officers and reporters are solicited directly in the course of reporting. Ideas of others, either authors or hearers will be welcome and should be sent to the Papers Committee at Headquarters. Volunteer descriptive comments on particularly good presentations should be especially helpful. Trials during the past two years showed that the plan had promise and at the approaching Annual Meeting we shall have a further trial.

The committee hopes to find some of the answers regarding the presentation of papers in our Society and perhaps at the same time obtain livelier, more stimulating sessions at the Annual Meeting.

## Symposium on Observation of Structures

THE Laboratorio Nacional de Engenharia Civil of Lisbon, a member of RILEM (Union of Testing and Research Laboratories for Materials) will hold a symposium on observations of structures the week of October 24, 1955, in Lisbon.

Methods as well as measurement techniques used for the observation of different types of structures such as bridges, dams, and buildings will be presented and discussed. Specific topics include instruments, techniques, mechanical properties, loads, planning, and analysis.

Further information can be obtained from Laboratiorio Nacional de Engenharia Civil, Av. do Brazil, Lisboa, Portugal.

## Administrative Committee on Research Notes

### Impressions of ASTM Research

by R. C. Alden[1]

It is my good fortune to be a member of the present Administrative Committee on Research. At its last meeting (November 15, 1954) I was very much impressed by the way in which this committee is discharging it responsibilities to the Society. With a very small fund available, the committee is using its resources quite effectively. It seeks to catalyze research rather than to perform research. In a few instances funds will be allocated but usually these are in token amounts, the chief contribution being to provide the prestige of the Society in carefully examined projects for the furtherance of the Society's main objective: *The promotion of knowledge of the materials of engineering.*

One of the chief activities of the ACR is to maintain its list of "Some Unsolved Problems." The purpose of this list is to provide research organizations, perhaps chiefly academic researchers, with an appraisal of where research efforts are likely to be fruitful.

ACR, itself, has contributed very little to this list, which is primarily a compilation of many lists from the numerous working committees of the Society. As a member of ACR it is my feeling that the working committees of the Society could well afford to devote more attention to this activity than has been devoted to it in the past. The list, "Some Unsolved Problems," could, if carefully handled, become a kind of national—even international—research and development council devoid of authoritarianism. However, to achieve such stature far more effort must be put into it.

We are all accustomed, as active members of the Society, to working hard in our own specialized fields of standardization. We and our employers are willing to contribute the fruits of our own research and development work to the Society. The reason we are willing to do this is because *a real need* for standardization appears. Knowledge must replace ignorance lest development of a product useful in our civilization be retarded. In a way, the Society catalyzes us all so that the standardization which results has actually cost many times more than will ever appear in the Society's budget.

It is the goal of ACR to extend the catalyzing influence *of the real need* beyond the Society itself. The logic is simple. If it succeeds so well internally, it should succeed externally.

If these few words of mine stimulate any committee officers or the chairmen of any of the numerous subcommittees on research, let me make a few suggestions which result from watching these activities in Committee D-2 on Petroleum Products and Lubricants. Fortunately for the ACR objectives, the oil industry and many of the consumers of petroleum products devote large corporate budgets to aggressive and comprehensive research and development programs. In addition, several trade associations, notably the American Petroleum Inst., support large research programs. Thus, in spite of some real, though sporadic effort, Committee D-2 has been unable to make much contribution to "Some Unsolved Problems." Here, however, are the suggestions:

1. The chairman of the subcommittee on research must be one who is sold on the objectives, who will take the time to familiarize himself with the past history and present status of the project and who has the time and patience to solicit and screen "unsolved problems" from the working subcommittees.
2. Busy as the working subcommittees are with their active problems letters are quite ineffective. It takes personal appearances before these busy groups to stimulate their imagination in the desired direction.
3. In general, "unsolved problems" should be of a research rather than of a development nature. It is not cricket to propose "unsolved problems" when it is known that proprietary research is in progress.
4. Along the same lines, to avoid duplication of effort, "unsolved problems" should take into account what is known about research efforts in the particular field.
5. "Unsolved problems" should be as specific as possible.
6. Although chief reliance should be put on the subcommittee on research, the final actions should be passed on by the main advisory committee, at least.

In conclusion, the Administrative Committee on Research believes that its present list of "Unsolved Problems," although a good start, falls far short of what could be achieved if the full talent and imagination of the Society's membership could be more effectively mustered to the project.

[1] Chairman, Research Planning Board, Phillips Petroleum Co.

# Technical Committee Notes

*Activities of the ASTM technical committees which met in Cincinnati during the Society's Committee Week, January 31 to February 4, are summarized on these pages. For convenience, other committee meetings held recently in other cities are also included in this report.*

## A-1 Steel

While Manhattanites were enjoying the first ice skating in Central Park for many years, several hundred of the hard-working members of ASTM Committee A-1 on Steel were engrossed in a three-day meeting at the near-by Hotel Warwick on January 24, 25, and 26, 1955. Major activity seemed to be centered on forgings and tubular products.

### Forgings

The requirements for mechanical testing in all the forging specifications were revised in accordance with the lately developed Methods A 370 covering mechanical testing of steel products. In Specification A 293 covering turbine rotors and shafts, two new classes will replace the present class 7 (125,000 psi tensile; 95,000 psi yield strength). Class I of Specifications A 105 and A 181 for forged flanges, fittings, and valves will have a maximum carbon limit of 0.30 per cent imposed.

Specification A 336 for alloy steel seamless drum forgings received much attention. The tensile properties for grade F 22 (2½ per cent chromium, 1 per cent molybdenum) are being lowered. The phosphorus and sulfur maximum limits for grades F 1, F 2, F 22, F 30, F 31, and F 32 were raised to permit acid open-hearth steel to be supplied. A new grade of steel (5 per cent chromium, 0.15 per cent carbon max) will be added, to be used for applications involving welding.

A recommended practice for ultrasonic testing and inspection of heavy steel forgings is a good possibility for publication in 1955. Progress was reported in an investigation of the effect of hydrogen in steel forgings. This activity will be coordinated with similar activities in the Forging Manufacturers' Assn. and the Acid Open-Hearth Research Assn. Another specially appointed group is starting to develop tests and criteria for judging the sensitivity to fracture of heavy rotor forgings.

### Tubular Products

The carbon content of boiler or superheater tubes ordered to Specification A 210 will be reduced from 0.35 per cent to 0.27 per cent maximum. A standard practice for pipe lengths of austenitic steel covered by Specification A 312 has been established and will be incorporated in the specifications in place of the present Section 18. A new 70,000-psi tensile strength steel will be added to Specification A 106 for seamless carbon steel for high-temperature service. Specification A 358 covering electric fusion-welded austenitic pipe for high-temperature service will have types 309 and 310 added.

There will be a slight change in the chemical requirements for those alloy steels containing a nominal molybdenum content of ½ per cent. Likewise the tables of chemical requirements in all the tubular product specifications have been in a state of flux during the past several years. It appears that a final suitable form has been agreed upon.

### Sheet and Strip

Specifications A 245 and A 246 covering structural quality carbon steel sheets will very probably be combined. Also commercial quality sheets will be covered by another specification with strip included, if feasible. These developments are necessitated by the changing methods of manufacture.

### Bolting

In answer to specific requests from consumer interests a proposed specification for galvanized transmission tower bolts has been developed and appears to be cleared for publication during 1955. The low-temperature bolting Specification A 320 will cover grades 4340 and 8640. In the four bolting Specifications A 193, A 194, A 261, and A 320, it is proposed to change the requirements for minimum clearance for the screw threads. This action is necessary since the American Standard B 1.4-1945 presently referenced will become obsolete.

## A-3 Cast Iron

Revisions to simplify Tentative Specification A 43 for Pig Iron were discussed and the committee recommended the elimination of grades not being used or produced commercially and the addition of a new Bessemer grade with lower manganese content. Simpler chemical composition requirements for phosphorus were also recommended. Subject to approval by committee letter ballot, these recommendations will be submitted for adoption by the Society at its Annual Meeting in June.

Subject to affirmation by letter ballot, the committee recommended that the following tentatives be adopted as standard:

Specification for Automotive Gray Iron Castings (A 159)
Specifications for Nodular Iron Castings (A 339)
Methods of Chill Testing of Cast Iron (A 367)

The committee also initiated work on a specification for nodular iron for use in unfired pressure vessels and a specification for heat-treated grades of the material.

## A-5 Corrosion of Iron and Steel

Three proposed tentatives, one of which has evoked considerable discussion, have been approved by letter ballot of the committee and are being submitted to the Administrative Committee on Standards. These proposals are: tentative specifications for zinc coating (hot dip) on assembled steel products; recommended practice for safeguarding against warpage and distortion during hot-dip galvanizing of steel assemblies; and recommended practices and design suggestions for providing quality zinc coating (hot dip) on assembled products.

The new hardware atmospheric exposure tests have been crystallized as regards number and type of specimens. The subcommittee in charge of this program hopes to procure the necessary specimens and place them on exposure by the end of this year. The low-alloy steels will be exposed bare and with hot-dipped and sprayed zinc and aluminum coatings. These specimens will be in the form of flats, round rods, and bends galvanized after cold bending. Exposures will be made in New York City and Kure Beach, N. C.

Anticipating the publication of the 1955 Book of ASTM Standards, many actions were taken on standards and tentatives. The standard Method of Test for Uniformity of Coating by the Preece Test (Copper Sulfate Dip) on Zinc-Coated (Galvanized) Iron or Steel Articles (A 239) and the Recommended

## Committee Week Report

Practice for Safeguarding Against Embrittlement of Hot Galvanized Structural Steel Products and Procedure for Detecting Embrittlement (A 143) were recommended for reaffirmation as standard.

The Standard Specification for Zinc-Coated Iron or Steel Chain-Link Fence Fabric Galvanized After Weaving (A 117) and the Tentative Specification for Zinc-Coated Iron or Steel Chain-Link Fence Fabric Galvanized Before Weaving (A 337) will be withdrawn. Revisions in tentatives include change from term "ordered coating" to "class coating" in A 93 (zinc-coated iron or steel sheets) and A 361 (1.25 oz ordered coating roofing sheets); sampling for weight of coating provisions for narrow widths in A 308 (long terne sheets); inclusion of splices, deletion of Preece test, and addition of "basis of purchase" requirement in A 116 (zinc-coated farm-field fencing).

### A-7 Malleable Iron Castings

Reflecting advances in pearlitic malleable properties and uses, Committee A-7 recommended substantial advancement of specification values. The new values range from 65,000 psi tensile strength with 45,000 psi yield point and 10 per cent elongation, to 100,000 psi tensile strength with 80,000 psi yield strength and 2 per cent elongation. Intermediate grades are included. These new values would tentatively replace those now contained in Standard Specification for Pearlitic Malleable Iron Castings (A 220).

Substantial progress was reported on the development of a white iron sample at the National Bureau of Standards. Chairman W. A. Kennedy announced that a contribution of material had been made by Chain Belt Co. and of funds to defray the cost of preparing the specimen by the Malleable Founders Society. The committee secretary reported steps taken by the Iron and Steel Technical Committees of the Society of Automotive Engineers to bring provisions of their malleable casting specifications into substantial agreement with those of ASTM Specification for Malleable Iron Castings (A 47).

### A-10 Iron-Chromium, Iron-Chromium-Nickel and Related Alloys

Cognizant of the fact that 1955 is Book of Standards year, Committee A-10 took action to advance Tentative Specification for Corrosion-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (A 296), Tentative Specification for Heat-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (A 297), Tentative Specification for Chromium-Nickel Corrosion-Resisting Steel Spring Wire (A 313), Tentative Specification for Corrosion Resisting Steel Billets and Bars for Reforging (A 314), and Tentative Specification for Stainless Steel Wire Strand (A 368) to standard.

Specifications A 240 (corrosion-resisting plate, sheet, and strip for pressure vessels), A 269 (austenitic stainless steel tubing for general service), A 270 (austenitic stainless steel sanitary tubing), A 271 (austenitic stainless steel still tubes), and A 312 (austenitic stainless steel pipe) are being considered for revision with the thought of making heat-treating requirements mandatory.

A new recommended practice for conducting acidified copper sulfate test for intergranular attack in austenitic stainless steels has been submitted for letter ballot approval of the main committee.

An extensive program of atmospheric tests, planning for which was begun in 1941 and which suffered severely as the result of two intervening wars, is reaching the point where actual exposure of specimens is anticipated within the next year.

A task group has been appointed to review work under way in the field of stress corrosion by other organizations. If the preliminary investigations of this group warrant such action it is planned to compile a series of case histories and known remedies.

### B-3 Corrosion of Non-Ferrous Metals and Alloys

Highlighting the activities of Committee B-3 is the anticipated report of Subcommitte VI on Atmospheric Exposure which will summarize the results of 20 years' exposure of various nonferrous metals. This report will be a part of the 1955 Annual Report of the committee.

Next year will see the termination of a program designed to evaluate the relative corrosivity of the ASTM test sites. Some of the zinc and iron specimens in this test have been on exposure about eight years and the others have been used in a series of annual exposures.

An extensive Symposium on Atmospheric Exposure will be held during the 1955 Annual Meeting in Atlantic City. Tentative papers include corrosion studies of copper, zinc, aluminum, nickel, lead, and tin.

Subcommittee VII on Weather, devoted to the study of relative corrosivity of various locations and more recently in instrumentation, elected a new chairman, C. P. Larrabee, United States Steel Corp.

### B-5 Copper

During a series of meetings in New York City on January 20 and 21, Committee B-5 agreed to propose to the Society in 1955 many significant actions affecting the copper industry specifications.

Another effort will be made to prepare a recommended practice for dimensional measurements. The committee is also recommending to ASTM Committee E-1 on Methods of Testing that Method E 18 for Rockwell hardness testing be revised to include correction tables for cylindrical specimens when a $\frac{1}{16}$-in. ball penetrator is used.

In Specification B 100 for bridge plates, the present physical properties will be limited to material 18 in. and under in width and $\frac{3}{4}$ in. and under in thickness. Physical properties for large sizes will be subject to agreement. A 90–10 copper-nickel alloy will be added to Specification B 171 for condenser tube plates. Also proposed is the addition of a hardness conversion table to Specification B 194 for copper-beryllium alloys.

A new specification for tellurium-bearing copper rod is being prepared for consideration by Committee B-5. Also one for Type B copper tube (threadless pipe) and another for copper-silicon alloy pipe and tube are under study.

New copper-silicon alloys are proposed to be added to Specifications B 96 and B 97 covering plate and sheet and B 98 covering rod and bar. The new alloys are a result of many years' work by G. H. Bohn at Linde Air Products Co., Division of Union Carbide and Carbon Corp., and are primarily intended to guarantee consistent welding results.

### B-6 Die-Cast Metals and Alloys

Subcommittee I on Aluminum Alloy Die Castings approved a new table of physical properties of the die-casting alloys to be incorporated in the Specifications for Aluminum Base Alloy Die Castings (B 85); also, new typical mechanical properties for alloys SC84A and SC84B. Both of these items are subject to subcommittee letter ballot. Work on obtaining up-to-date typical

mechanical test values on the other aluminum alloys continues.

Subcommittee II on Zinc-Base Die Castings received an interim report from the task group investigating the properties of Alloys 21, 23, and 25 of Specifications for Zinc-Base Alloy Die Castings (B 86). Subcommittee V on Corrosion is looking into the desirability of obtaining corrosion data on die-cast test bars exposed at a proposed test site in the Mojave Desert.

### B-7 Light Metals and Alloys

Reversing its decision of several years ago, the committee decided that the ASTM should recommend to the American Standards Association that the United States take an active part in the ISO[1] Technical Committee TC 79 on Light Metals and Their Alloys.

Several revisions of light metals standards are being made, subject to letter ballot approval of the committee. The Specification for Aluminum-Base Alloy Sand Castings (B 26) is being revised to include additional grades and also a "basis of purchase" requirement. This same "basis of purchase" requirement is to be included in the specification for Aluminum-Base Alloy Permanent Mold Castings (B 108). The specification for Aluminum and Aluminum Bars, Rods, and Wire (B 211) is being studied with the thought of including in this specification aluminum alloys in rolled shapes. The Recommended Practice for Coatings of Light Metals and Alloys (B 275) will be recommended for adoption as standard. In addition to this tentative, all of the tentatives under the jurisdiction of Subcommittee III on Wrought Aluminum and Aluminum Alloys will be similarly recommended.

New work in addition to the inclusion of rolled shapes in B 211 includes identification marking of ingots and wrought products, a specification for aluminum seamless tubing as well as round aluminum welded tubes, and the review of the dimensional tolerances in the specification for Aluminum Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers (B 234).

### B-8 Electrodeposited Metallic Coatings

One of the most important developments under consideration in the committee is the crystallization of final plans for the Symposium on Properties, Tests, and Performance of Electrodeposited Metallic Coatings to be held during the 1956 Committee Week in Buffalo. The symposium will comprise eight papers including papers on exposure tests and results, thickness, luster, salt spray tests, metal cleaning, conversion coatings, and the comparison of zinc and cadmium plated deposits. It will be repeated at the ASTM National Meeting in Los Angeles in September, 1956.

A special task group reported that the results of a survey do not indicate sufficient interest at the present time for the preparation of specifications for plating metals. A new task group has been appointed to write specifications on nickel deposits produced by chemical reduction methods, better known as "electroless" nickel.

Subcommittee II on Performance Tests is planning a "Fourth Program" on the corrosion resistance of various combinations of copper-nickel-chromium deposits on steel. Included in the study will be panels with and without strike platings of nickel and copper—both buffed and unbuffed. Varying thicknesses of chromium will also be considered.

Work is in progress on thickness measurements of electrodeposits by the anodic solution method; also ductility measurements. Various stages of progress were reported by task groups considering Recommended Practices for the Preparation of and Plating on Lead and Lead Alloys, and on Malleable and Cast Iron, and a third group developing a recommended practice for cleaning of metals prior to electroplating.

A note is to be added to the Recommended Practice for Chromium Plating on Steel for Engineering Use (B 177) cautioning against the baking of chromium-plated steel parts to relieve hydrogen embrittlement. The cautionary note will point out that excessive baking results in the reduction of fatigue strength.

An exposure test of cadmium-treated electrodeposited specimens will be initiated in the near future with exposures at Kure Beach, New York City, and The Rock Island Arsenal.

### C-1 Cement

Significant changes in the physical requirements for portland cement, as covered in the Standard Specification for Portland Cement (C 150) and in the Standard Specification for Air-Entraining Portland Cement (C 175), were accepted subject to letter ballot of Committee C-1. If approved, these recommendations will be presented to the Society at its Annual Meeting in June for adoption. Culminating related discussions over a period of several years, the committee will recommend the deletion of the alternate strength requirements as now expressed in C 150 in terms of tensile strength of mortar briquets. Based on a recent country-wide survey of strength tests made by numerous laboratories on many cements, a revision in the present compressive strength requirements will be recommended, most of the revisions being an increase in the strength requirements.

A new tentative method for the determination of false set of portland cement was accepted for letter ballot of the committee. This method involves the use of the mechanical mixer, and a modified Vicat apparatus using a brass rod with a stud on one end replacing the standard needle.

A number of existing tentative methods were recommended at the meeting for adoption as standard. These include the short method for heat of hydration (C 186); normal consistency (C 187); fineness by air permeability apparatus (C 204); and definition of the term pozzolan (C 219).

Continuing the practice of including the presentation of a paper on subjects within its scope before the committee, an interesting talk was given by M. A. Swayze, Director of Research, Lone Star Cement Corp., and current ASTM Director, tracing the history of the strength testing of cement. One point of interest was that the first compressive test was developed and used in 1848.

Approval was given to the presentation of certificates to all honorary members of the committee, thus recognizing in visible form the honor which has been bestowed upon nine present and former members of the committee.

### C-7 Lime

A number of projects pertaining to various lime requirements for chemical industries were reported at the meeting of Committee C-7. A specification for lime for silica brick for the refractory industry is being prepared at the request of Committee C-8 on Refractories. Involved in this specification is the need for establishing delayed slaking requirements and a task group is working on a performance test needed for this purpose.

A property specification for lime and limestone for use in glass manufacture is being considered, involving four types of glass usage; namely, optical, plate, sheet, and bottle glass. A specification for precipitated calcium carbonate is

[1] International Organization for Standardization.

## Committee Week Report

also to be considered after definite need is established for such a standard. The need for requirements for lime used in hypochloride bleach manufacture was mentioned, but insufficient knowledge of the requirements will necessitate further investigation.

A test procedure for determining the neutralization factor in determining the acidity of lime will be prepared and distributed to Committee C-7. A need was expressed for a better method for direct determination of unhydrated calcium or magnesium oxide in lime products with the versenate method still under consideration.

A new Subcommittee on Pozzolanic Materials was established, with Nathan Rockwood, well-known authority on cement and lime, as chairman. Because a considerable amount of preliminary investigation and survey of available information will be necessary, a symposium was suggested for presentation in 1956.

The committee authorized a letter ballot on the combining of the two specifications for hydrated finishing lime, C 6 and C 206, under one designation.

### C-8 Refractories

The newly recalibrated pyrometric cone series included in the Method of test for Pyrometric Cone Equivalent (C 24) was presented and discussed for the first time by Committee C-8. The new series is the result of extensive study and research on the part of The Edward Orton, Jr. Ceramic Foundation in conjunction with the National Bureau of Standards. One purpose of the revision is to smooth out the time intervals between standard cones as used in the P.C.E. Test. The proposed changes include the deletion of Cones Nos. 28 and 30 and the addition of Cone No. $30\frac{1}{2}$. The committee has reviewed existing ASTM standards involving the use of standard pyrometric cones for revision and finds that the Specification for Ground Fire Clay (C 105) is the only one needing editorial revision.

The committee is working closely with the National Bureau of Standards on the development of new standard samples of silica brick of 0.2 and 0.8 per cent $Al_2O_3$. A task group has been formed to coordinate with Committee C-7 on Lime in the development of a specification for lime for silica brick. In the preparation of a silica classification, a program of cooperative testing is under way in eight laboratories for the development of a test method using coded samples. A complete revision of the Standard Classification of Fireclay Refractories (C 27) was reviewed in detail and a revised draft will be circulated for committee ballot.

Preparation of a flame photometer method was reported by the Section on Chemical Analysis for use in the determination of alkalies. Work is continuing on thermal conductivity measurements in the field of special refractories by the Special Refractories Assn., although no actual cooperative efforts have been established with the committee.

A number of standards which have stood for six years or more were reaffirmed, and a letter ballot will also be conducted on all standards under the jurisdiction of the committee for recommendation to the American Standards Assn. as American Standard.

### C-9 Concrete and Concrete Aggregates

Twenty-three of the thirty subcommittees held meetings, all well attended by both members and visitors.

In the study of chemical reactions of aggregates in concrete, two methods have been recognized, two of which were subject to cooperative testing; namely, the Conrow and the Scholer test methods. The Conrow test is now an ASTM tentative method (C 342) and a description of the Scholer test method was published as an appendix to the Annual Report of the committee in the 1954 *Proceedings*. It has now been felt necessary to change from the machine mixing to hand mixing in method C 342 and a revision was therefore recommended covering this change. As part of the study of elastic and plastic properties of concrete, a definition of creep has been agreed upon by a subcommittee for use in developing a test method. The use of the soniscope in evaluating durability of concrete was discussed in subcommittee and an attempt will be made to secure reports from large organizations in connection with the use of the soniscope on concrete structures. An effort will be made to form a definition of durability. The sonic method for fundamental and torsional transverse frequency (C 215) has been completely revised to include a longitudinal frequency determination. This revision will be circulated for letter ballot to the committee.

In determining air content of concrete, action was taken to withdraw the existing volumetric method (C 173) and replace it with a new gravimetric method. The pressure method for air content (C 231) will be revised to include the Washington Meter apparatus. A test procedure using the Kelly Ball Penetration apparatus for measuring consistency of concrete is now being drafted. Consideration is also being given to the development of a method for determining the amount of cement in fresh concrete. Revisions in the Specification for Concrete Aggregates (C 33) were agreed upon for subcommittee letter ballot involving more definite limits on deleterious materials. A specification is being prepared for natural pozzolanic materials for use in portland-cement concrete. In connection with this proposed specification, as well as with the new specification for fly ash (C 350), it is felt desirable to establish uniformity requirements on specific gravity of the materials; and an industry survey will be conducted to obtain information on fly ash.

A proposed specification for packaged dry combined materials for concrete and mortar was accepted for distribution to the committee and for publication in the ASTM Bulletin (see p. 28) as information. This specification covers the production, properties, and packaging of dry combined materials for concrete, concrete mortar, and masonry mortar. In preparing for the necessary action at the Annual Meeting and for inclusion in the 1955 Book of Standards, the committee acted to recommend for adoption as standard several tentatives and tentative revisions, as to reaffirm those standards which have been published for more than six years without change.

### C-11 Gypsum

The attention of the committee was focused on certain accessories used in connection with gypsum products, in addition to newer type products now being used. The Subcommittee on Structural Products is concerned with the development of specifications for paper used in gypsum board products, in which thickness and density are the principal requirements. Subcommittee consideration is also being given to a method of test to evaluate mold resistance treatment of face paper on gypsum formboard. Two methods under consideration are the TAPPI Method T487 and the Buchman Laboratory (Bulab) Method. The recommendation will be made at the next meeting for inclusion of the preferred method in the present ASTM Standard Methods of Testing Gypsum Products (C 26).

A proposed specification for nails used with gypsum wallboard is receiving preliminary consideration and will be presented at a later meeting of the committee for further action. A proposed

specification for reinforced precast gypsum roof-deck units was tabled for future consideration due to pending changes expected in both the use and physical requirements of this product. The Tentative Specification for Gypsum Concrete (C 317) will be recommended to the Society for adoption as standard.

Considerable attention is being given to aggregates used in gypsum products. Progress was reported in a research program using lightweight aggregate in which four laboratories are conducting a test series involving all factors which may affect performance of gypsum plaster with lightweight aggregate. Variations in densities and proportions are being made using a considerable number of sources of vermiculite. The results of completed tests on the effect of grading on perlite aggregate will be distributed for subcommittee review. Also being distributed is a survey made of sand gradings reportedly used throughout the country.

Approval was given to important additions to the membership of the committee which will provide a much broader representation of the various interests in the field of gypsum and gypsum products. The nine new members are primarily of consumer and general interest classification, including representation from such interests as contractors, Federal Housing Administration, Department of Defense, National Association of Home Builders, and Armour Research Foundation.

### C-15 Manufactured Masonry Units

Combining the new with the old, the committee considered several new fields of standardization and reviewed the status of existing standards.

The new subcommittee on Waterproofing Materials for Unit Masonry Walls discussed at some length the scope of activity in which it will operate. In order to crystallize the thinking of the group, assignments were made to prepare for consideration suggested methods of testing; the relationship to other factors, such as the effect of water or moisture from other than exterior sources; and to define by title the function of the subcommittee.

An expansion of scope of the Subcommittee on Chemical Resistant Units was presented for consideration. Specifications for carbon and graphite brick used for lining steel vessels were proposed as important additions to the group of chemical-resistant units now covered. Specifications are needed for corrosion-resistant membrane liners and coatings for steel vessels, including such materials as plastics, metals, rubber, and asphalt. To accomplish this work, an expansion in membership of the committee is recommended to include further representation from the chemical industry.

A survey of manufacturers of floor brick, including packing house flooring, indicated a desire for standard specifications, an assignment given to the Subcommittee on Chemical Resistant Units.

In the review of existing standards, the committee took action to submit to letter ballot a revision deleting the requirement for marking structural clay tile; recommended for adoption as standard the tentative revision of Specification C 34 pertaining to nominal thickness; the adoption as standard of the Specification for Drain Tile (C 4); and a revision of the specification for concrete brick (C 55) with respect to reference to the proper absorption test method, C 140.

## Committee Week Report

### C-17 Asbestos-Cement Products

Further coverage in the field of asbestos-cement products was reported at the meeting. The committee has planned to develop a specification for asbestos-cement sewer pipe as a companion to the existing tentative specification for asbestos-cement pressure pipe (C 296). A method for determining the degree of "cure" is being considered, along with continued studies on procedures for measuring handleability and organic content of asbestos-cement products.

Two interesting talks presented at the meeting dealt with the two basic ingredients in asbestos-cement products. The paper on asbestos cited the various basic tests and characteristics required to make it suitable for use in asbestos-cement products. The second paper reviewed cement with reference to the special tests needed to evaluate this material as a suitable ingredient in these products.

### C-22 Porcelain Enamel

Several new test methods for evaluating basic materials in porcelain enamel have been completed, it was reported at the meeting of Committee C-22 at the new General Electric Co. plant in Louisville, Ky., on February 1, 2, and 3. Approved for letter ballot of the committee was a tentative method of test for fusion flow of porcelain enamel frits (flow-button method); two suggested methods of tests to be published as information only; and a tentative classification of water used in milling of porcelain enamel. The two suggested methods involve the determination of sag resistance of steel sheets for porcelain enameling and the set characteristics of porcelain enamel clays (slump method).

A complete review of the comprehensive list of definitions of terms (C 286) has reached 40 per cent completion, and a considerable number of revised definitions will now be submitted to letter ballot of the committee. Two important and significant terms agreed upon were "porcelain enamel" and "ceramic coating."

A number of projects are in varying stages of completion for both basic materials and for finished products. Nine projects involving basic materials include a development of methods of tests for evaluation of enameling iron, composition of water for enameling, consistency of porcelain enamel slip, torsion, fusibility, evaluation of clay set, measurement of coefficient of thermal expansion, and spontaneous chipping. Eleven projects on finished products include the development of test method for abrasion, porcelain enamel thickness, thermal shock, alkali resistance, scratch resistance, continuity of coating, metal marking, color, hot water resistance, mineral acid resistance, and bleach resistance.

Very interesting work is under way in the Subcommittee on Research. Ten problems under investigation include the effect of long- and short-term heating on the physical properties of coated metal, coefficient of expansion, evaluation of enameling iron, fishscale, problems of waste disposal, evaluation of clay, evaluation of weathering test, evaluation of emissivity properties of porcelain enamels, and the engineering properties of porcelain enamels.

Following the main committee meeting on February 3, a plant trip was conducted, which provided an interesting inspection of one of the most modern and largest manufacturing plants in the electrical appliance field.

### D-1 Paint, Varnish, Lacquer, and Related Products

The 81 meetings of Committee D-1 and its subgroups in Roanoke, Va., February 21 to 24 were attended by 202 members and guests. Actions were taken on a number of new methods of test and specifications, and also on revisions of existing standards.

## Committee Week Report

One of the highlights of the meeting was a dinner on Wednesday evening at which a talk on "Depth Perception in Color Photography," by Ralph M. Evans, Eastman Kodak Co., was illustrated with over 100 colored slides. Another interesting feature of the meeting was the presentation of a technical paper on "Statistical Analysis and the Design of Experiments," by W. J. Youden, Consultant, National Bureau of Standards. Discussions were held during the meeting regarding the desirability of organizing a program of work on statistical analysis in order to assist the various subcommittees in the evaluation of data resulting from their cooperative test programs.

After review by a special committee of the need for standards in the field of caulking compounds, action was taken to set up a new Subcommittee on Putty, Caulking Compounds, and Similar Mastic Materials. A new Subcommittee on Publications was also appointed for the purpose of reviewing reports and results of test data from committee investigations and to make arrangements for the publication of such material.

The Advisory Committee also considered the need for making available information on performance test methods that would be of particular interest and assistance to the consumer. It was felt that a symposium on this subject would be very timely, and plans were initiated to sponsor such a session at the June, 1956, ASTM Annual Meeting. This symposium might present information on the factors involved in such tests, the available ASTM methods which apply, and a discussion of the significance of the various tests.

The recently organized Subcommittee on Latex and Emulsion Paints has organized five working groups which are undertaking programs of work on the following subjects: (1) washability, (2) efflorescence, (3) freezing and thawing resistance, (4) package stability, (5) exterior latex paints.

Two new tentative specifications and three tentative methods of test were presented by the Subcommittee on Lacquer Solvents and Diluents. The new specifications cover acetone (99.5 per cent grade) which replaces D 329, and Specifications for Methyl Isobutyl Ketone (98.5 per cent grade) which replaces D 1153. The methods of test cover procedures for determining water in lacquer solvents and diluents, a test for alcohol in methyl isobutyl ketone, and a test for permanganate time of lacquer solvents and diluents. The latter method serves as a means of detecting in alcohols or ketones the presence of impurities which reduce potassium permanganate.

The Subcommittee on Definitions reviewed at its meeting several definitions for latex paint. Agreement was reached on the following for submission to committee vote: *"Latex paint.*—One containing a stable aqueous dispersion of synthetic resin, produced by emulsion polymerization, as the principal constituent of the binder. Modifying resins may also be present."

Additional cooperative work on low butyl solvents was planned with particular attention to be given to the narrow-range low-boiling solvents, such as methanol, and nitration grade benzene. Work is continuing on the development of a perspiration resistance test for lacquers. Preliminary results of initial observations of three collaborators on the exploratory investigation of moisture checking of furniture lacquers indicate this work should be continued using solid wood panels having smaller dimensions. Work of four collaborators on distensibility tests for predicting check resistance of wood lacquers was also reviewed. It is believed the expense of the modified Mullen burst machine would prohibit wide acceptance. The working group will test several lacquers at O C using the conical mandrel and a "stepped" mandrel on copper foil substrate to determine if a correlation can be obtained with the modified Mullen burst tester. The Tentative Methods of Test for Color of Clear Liquids (Platinum-Cobalt Scale) (D 1209), and for Residual Odor of Lacquer Solvents and Diluents (D 1296) were recommended for adoption as standard.

Revisions in the Tentative Methods of Testing Bituminous Emulsions for Use as Protective Coatings for Metal (D 1010) were accepted for D-1 committee letter ballot. These methods are under the joint jurisdiction of Committee D-1 and Committee D-8 on Bituminous Waterproofing and Roofing Materials, and the revisions have been approved by the latter committee.

New Tentative Specifications for Degummed Soybean Oil were accepted as tentative to replace the present Standard D 124. The revision is based on results of cooperative tests on the heat bleach color and quantitative break characteristics of six samples tested by ten cooperating laboratories. A new test for determining heat bleach color was recommended for inclusion in the General Methods of Testing Drying Oils (D 555). A new Tentative Method of Test for Closed Cup Flash Point of Drying Oils and new Methods of Sampling Drying Oils were submitted for publication as tentative. The Specifications for Raw Safflower Oil, published last year as information only, were recommended as tentative.

A new method for determining diene value of degummed cottonseed oil by spectrophotometric analysis was submitted for committee vote. Cooperative test studies are under way on hydrogen iodine value, total halogen iodine value, test methods for fatty acids, heat stability test, and the relationship of break and foots in raw linseed oil.

A revision of the Standard Method of Test for No-Pick-Up Time of Traffic Paint (D 711) was recommended. The changes comprise a revision of the wet film thickness and more flexible specification requirements for the test wheel. A new Method of Test for No-Smear-Time of Traffic Paint was recommended for publication as tentative.

The Subcommittee on Accelerated Tests for Protective Coatings has been continuing its study of the preparation of metal test panels for paint exposure tests. Work on the preparation of aluminum test panels is under way. Preliminary results on salt spray and water immersion tests were reported. A program for determining the uniformity of auto body steel as a possible source for test panels was considered. The reason has not been found for relatively wide variation in corrosion resistance in several lots of such panels, and work will be continued. It was decided to give consideration to other types of test panels such as tin, glass, fabric, and concrete.

A report was received of results by seven laboratories on three paint specimens subjected to the water fog test. Discussion of the results indicated that repeatability among replicates tested at the same time in any one cabinet is good. Results between laboratories are satisfactory when the paint specimens involved show wide variation. Results, however, are poor between laboratories when the differences are small among the paint specimens. A more closely detailed procedure will be written up for further cooperative studies.

The extensive data obtained in the cooperative tests in the light and water exposure program will be subjected to a statistical evaluation. Following review of preliminary tests on two types of architectural enamels, it was decided to undertake a cooperative test program on the yellowing of interior finishes. Plans were made to undertake a test program using a standard staining medium applied on both lacquer and enamel finishes to determine the staining of transporta-

and asphalt. To accomplish this work, formation only; and a tentative classi- visions of existing standards.

## Committee Week Report

tion finishes, such as used in the automotive field. Consideration is also being given to the need for undertaking work on the chemical resistance of appliance enamels.

The Subcommittee on Chemical Analysis is preparing a revised method for the chemical analysis of titanium dioxide pigments. Revision of the Standard Methods of Chemical Analysis of White Linseed Oil Paints (D 215) is under consideration.

The Subcommittee on Varnish presented as tentative a new method for abrasion resistance of clear floor coatings. This method determines abrasion by impingement on the coating of either falling sand or a carborundum air blast. The cooperative test data obtained in the study of this method will be submitted to the Publications Committee for consideration. A report was presented of the cooperative tests of acid value which showed very good agreement. A revised method will now be prepared using potassium hydroxide in methanol and a neutral solvent consisting of equal parts of isopropanol and toluene. The extensive test data will be subjected to statistical analysis to establish limitations of reproducibility. The method will then be submitted to committee vote and the results of the cooperative work submitted for publication.

The Group on Color of Transparent Liquids reported that significant differences in hue and in intensity have been found in the Nos. 7 and 8 color standards, between sets of standards held in several laboratories. The new chloroplatinate standards for Nos. 1 through 8 were found to be a little more red than the old iron-cobalt standards. This is thought to be nearer to the hues of modern paint vehicles. Six cooperators have agreed to prepare their matches for color standards Nos. 6 through 9 from solutions of chloroplatinic acid. These will be measured for spectral characteristics by Method D 307 and the results used to redefine the standard values. Consideration will also be given to using chloroplatinic acid solutions to redefine the whole series through standard No. 18.

A report of studies of tests for skinning of varnishes made by cooperating laboratories showed good agreement. The test results indicate that the present method can be made more satisfactory by a more precise definition of the container and of the examination schedule, plus some limitations on storage temperature. Further work is continuing on studies of rosin content. A third revision of the proposed method will be based on the current work at Battelle Memorial Inst., under the sponsorship of the Tall Oil Assn. This method involves saponification in a high-boiling solvent, isolation of the acids fraction by solvent extraction of the unsaponifiable portion, selective esterification of nonrosin acids, and titration of rosin acid. Cooperative tests by this method will be conducted on six varnishes as follows: a pentaerythritol soya phthalate which is free of rosin, three other portions of the same varnish to which have been added 0.6 per cent rosin, 5 per cent rosin, and about 0.1 per cent rosin in the form of tallate driers. The fifth and sixth samples will involve maleic and phenolic modifications of rosin. A separate attempt at rosin determination will be made through formation and separation of cyclohexylamine salts of rosin and its adducts. Chromatographic separations will be attempted.

The Subcommittee on Optical Properties submitted a revision of the Tentative Method for Calculating Small Color Differences from Data Obtained on the Hunter Multipurpose Reflectometer (D 1260) to include an alternate method of calculation. The Standard Method of Test for Daylight 45-deg 0-deg. Luminous Directional Reflectance of Paint Finishes (D 771) has been superseded by Method E 97. A proposed method for measurement of color difference with the Hunter Color Difference Meter was submitted as tentative for committee letter ballot. Also a revision of the Standard Method of Test for Tinting Strength of White Pigments (D 332) was recommended. Methods are being prepared for making color difference measurements by the following four types of apparatus: (1) General Electric spectrophotometer, (2) Beckman spectrophotometer, (3) Color Eye calorimeter, and (4) Colormaster colorimeter. There is in preparation a method for measuring hiding power of nonchromatic paints based on the use of the two-constant theory of Kubelka-Munk. It is proposed to express the hiding power in terms of spreading rate for a specific reflectivity at a contrast ratio of 0.98. A paper is being submitted for publication showing that the Kubelka-Munk equations agree with experimental data over the entire contrast ratio range, while the Fell relationship, the basis for some methods in use in the paint industry, is in disagreement in the high and low contrast ratio ranges.

The Group on Gloss and Goniophotometry has started a round-robin test to determine the reproducibility of goniophotometers of various types. This group is also undertaking a study of effect of changes in source aperture spread on the values obtained from glossmeters. The Group on Gloss of Clear Finishes Over Wood has developed a new method of test and has determined its reproducibility. Correlation of instrumental results with visual rating will be undertaken. It is expected that a report of the results of color difference measurements with the five instruments studied will be ready for publication this year.

The Subcommittee on Resins submitted for publication as information a proposed method of test for nonvolatile content of resin solutions using the foil method. Proposed Methods of Test for Vinyl Resins which includes procedures for determining polyvinyl alcohol, polyvinyl acetate, and total butyraldehyde were also submitted for publication as information only.

The Subcommittee on Shellac submitted revisions in the Standard Specifications for Dry Bleached Shellac (D 207), Orange Shellac and Other Lacs (D 237), and Shellac Varnishes (D 360).

A new proposed Recommended Practice for Reporting Particle Size Characteristics of Pigments was submitted for publication as tentative, designed to apply in most cases where well-known methods for determining these particle size characteristics in the subsieve range are employed, such as microscopic sedimentation and turbimetric methods, and partially to absorption and permeability methods. The standardization of the method of reporting the fineness characteristics of pigments and fine particles in the subsieve range should make comparison possible when the pigments are examined by any one of the many different methods now in use.

The Subcommittee on Flash Point submitted minor changes in the Standard Method of Test for Flash Point by Tag Closed Tester (D 56) which will improve the precision of the method but will not change the level of test results. This revision is being considered jointly with the corresponding subcommittee of Committee D-2 on Petroleum Products and Lubricants. Cooperative data submitted by seven laboratories on four samples tested by the Tentative Method of Test for Flash Point of Volatile Solvents by the Tag Open-Cup Apparatus (D 1310) confirm the precision statement in this method. The agreement between laboratories is still not as good as it should be. Revisions based on the cooperative data and discussions at the meeting will be submit-

## *Committee Week Report*

**The head table at Ohio Valley District dinner held in Cincinnati during Committee Week. Left to right: R. E. Hess, ASTM Associate Executive Secretary; C. H. Fellows, ASTM Vice-President; R. J. Painter, ASTM Executive Secretary; N. L. Mochel, ASTM President; J. C. Pitzer, District Chairman; G. B. Reisenberg, local Chairman, ASM; R. O. Schuettler, ASM; R. Armstrong, ASTM District Vice Chairman; A. Hurtgen, ASTM District Secretary; R. D. McGill, ASM.**

ted to letter ballot. The committee is undertaking development of a flash point method for viscous materials which will use a Tag open cup apparatus with a rotating cup and a fixed thermometer. Cooperative study of the proposed method will be made. The Bureau of Explosives laboratory, of the Association of American Railroads, is cooperating in this development.

Two new methods for determining fire retardance of paints by (1) cabinet method and (2) stick and wick method were submitted as tentative. The cabinet method determines qualitatively the fire retardance of a coating specimen upon a wood surface. Weight loss and char volume are reported. The test panel is placed at a 45-deg angle. The test flame is provided by 5 ml of pure absolute ethyl alcohol.

The stick and wick method determines in a quantitative manner three conditions associated with the early stages of combustion in a vertical wooden panel ignited by an alcohol flame. The data obtained cover (1) percentage weight loss, (2) average rate of vertical flame spread, and (3) average char height. Corresponding percentage factors (termed *W*, *F*, and *C*) are calculated by comparing the performance of a painted test panel with an unpainted control panel taken as 100. The test specimen is a pine stick 1 in. square by 16 in. long, coated with the paint to be tested. The flame is applied by a wick consisting of a 6-in. length of gauze folded twice lengthwise and saturated with pure absolute ethyl alcohol, to provide a constant source of ignition.

A revision was recommended of the Standard Method of Test for Consistency of Exterior House Paints and Enamel-Type Paints (D 562) to include a stroboscopic timer. A new method for determining hardness of paint, varnish, and lacquer film using the Tukon Hardness Tester was submitted for letter ballot as tentative. Cooperative laboratory studies are to be undertaken on the Sward Rocker and Pfund Hardness testers. Other subjects under study include consistency of paint, adhesion of paint films, water vapor permeability, rheological properties, measurement of film thickness, and density.

The Subcommittee on Painting of Metals reported completion of proposed Tentative Methods for Preparation of Aluminum and Aluminum Alloys for Painting. These methods provide for the use of four types of treatment and 15 individual treatments. A letter ballot in the subcommittee has also been completed on Proposed Methods for Preparation of Magnesium Alloy Surfaces for Painting.

### D-2 Petroleum Products and Lubricants

Committee D-2 held an excellent and productive six-day meeting in Houston, Tex., on Feburary 6 to 11. This was the first meeting of the committee held in the Southwest, and the attendance of 285 registered members and guests indicated that the time and place were well chosen.

One of the highlights of the meeting was a technical Symposium on Mechanical Stability of Lubricating Greases, comprising 15 technical papers sponsored by Technical Committee G on Lubricating Grease. The interesting discussion that followed the various papers gave evidence of the extent of interest in this subject.

L. L. Davis, formerly with the Continental Oil Co., was elected an honorary member of Committee D-2 in appreciation of his many contributions and services to the committee.

Technical Committee A on Gasoline reported that it plans to submit in June a revision of the Tentative Specifications for Gasoline (D 439) after review of the National Motor Gasoline Winter Survey, published by the U. S. Bureau of Mines. The committee also plans to recommend a change in the requirement for the Reid Vapor Pressure by increasing the recent maximum limit from 9.5 lb to 10.5 lb, with a footnote

Memorial Inst., under the sponsorship photometers of various types. This cussions at the meeting will be submit-

stating that the former value would still apply in several states. Technical Committee A is considering a Symposium on Vapor Phase Oxidation of Gasoline Performance at one of its future meetings, possibly in 1956.

The Technical Committee on Light Hydrocarbons recommended the adoption as standard of the Tentative Method of Test for Oxygen in Butadiene Vapors (Manganous Hydroxide Method) (D 1021), Test for Peroxides in Butadiene by Ferrous-Titanous Method (D 1022), and Test for Vapor Pressure of Liquefied Petroleum Gases (D 1267). The membership of Section I on Chemical Utilization, including pure hydrocarbons, is to be expanded to include representatives of the synthetic rubber producers so that the committee will be prepared to establish any needed standards when the Government synthetic rubber plants are sold to industry. The committee has under study several new test methods for liquefied petroleum gases, including an improvement in the weathering test which was published as information two years ago.

The Technical Committee on Aviation Gasoline received a request that a study be undertaken of the tests for autogenous ignition temperature of petroleum products. The present ASTM Method D 286 is considered inadequate and not in line with current practice. Consideration will be given to methods recently developed by the Bureau of Mines and the National Fire Protection Assn. Work is also being initiated on development of a method for detection of contaminants in aviation gasoline, such as kerosine, fuel oil, etc.

The Division on Combustion Characteristics recommended revision of the Standard Method of Test for Knock Characteristics of Motor Fuels by the Research Method (D 908) and also of the Tentative Method of Test for Knock Characteristics of Aviation Fuels by the Aviation Method (D 614). In cooperation with the Technical Committee on Gasoline this division is planning to sponsor a symposium which would cover the various methods now in use for expressing octane number.

The Division on Measuring and Sampling submitted revisions in the Tentative Method of Calibrating Liquid Containers (Upright Tanks) (D 1220), which will involve the tension requirements in calibrating working tapes, designation of effective data for tank gage tables, and displacement due to internal shell incrustation. Three new methods for calibration of tanks were also submitted as tentative covering (1) spheroids, (2) spheres, and (3) tank cars. The committee also has in preparation a

## *Committee Week Report*

new ASTM manual for calibrating stationary horizontal cylindrical tanks by the external strapping method. Consideration is also being given to calibration methods for barges and for truck and trailer tanks.

Action was taken to submit to letter ballot of the committee a new table for reduction of volume to 60 F against API gravity at 60 F for the temperature range from 0 F to −50 F. This will be an extension of the present Table 6 of the ASTM-IP Petroleum Measurement Tables. A companion abridged table for reduction of volume to 60 F against API gravity at 60 F was also accepted for letter ballot. This likewise covers the temperature range from 0 F to −50 F, and will be an extension of Table 7. A new Table 34 for Liquefied Petroleum Gases has also been completed, and after committee approval will replace the present Table 32. Revisions for immediate adoption were submitted in the Standard Method of Test for API Gravity of Petroleum and Its Products (Hydrometer Method) (D 287). The Tentative Method of Sampling Liquefied Petroleum Gases (D 1265) was recommended for adoption as standard, this action being taken jointly with Committee D-3. This division is planning to sponsor a symposium on automatic sampling at the February, 1956, meeting.

The Research Division on Elemental Analysis reported that E. L. Baldeschwieler had been made an honorary member of the division. A new proposed method for determining tetraethyllead by polarograph was submitted for publication as information. Revisions were recommended in the Tentative Method of Test for Sulfur in Petroleum Products by the Lamp-Gravimetric Method (D 90), and Test for Sulfur in Petroleum Products and Liquefied Petroleum Gases by the $CO_2$-$O_2$ Lamp Method (D 1266). The division reported results of cooperative laboratory studies on the determination of tetraethyllead in gasoline. These will be continued using polarographic methods and apparatus.

The research Division on Hydrocarbon Analysis submitted ten recommendations for committee action. The Tentative Method of Test for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents (D 611) was revised to include more complete specifications for reagents, a new statement of precision based upon cooperative test data, and several editorial changes for clarity.

Revisions in the Tentative Method of Test for Bromine Number of Petroleum Distillates (Color-Indicator Method) (D 1158) were recommended to include data on the bromine numbers of propylene, trimer, and tetramer, with suitable footnotes on the origin of these materials and methods of determining values given. The Tentative Method of Test for Hydrocarbon Types in Liquid Petroleum Products (Fluorescent Indicator Adsorption (FIA) Method) (D 1319) was revised by inclusion of a note in the scope stating that cooperative data show that for best results test samples should be depentanized. In addition, the procedure for making readings on the column has been modified. The Standard Method of Test for Olefinic Plus Aromatic Hydrocarbons in Petroleum Distillates (D 1019) was reverted to tentative and revised to include a new test method to guard against oversulfonation. Two test standards for determining the adequacy of shacking will be employed rather than relying upon the instructions for the shacking procedure. The Tentative Method of Test for Measurement of Freezing Points for Evaluation of Purity (D 1015) was recommended for adoption as standard with revisions to incorporate the sample drying apparatus which now appears in Method D 1016. The Tentative Method of Test for Determination of Purity from Freezing Points (D 1016) was recommended for adoption as standard with revisions to include a new note in the scope to indicate that the numerical constants given in the method will be maintained in agreement with the most recent published constants of API Research Project 44. The Standard Method of Test for Density of Hydrocarbon Liquids by the Pycnometer (D 941) was recommended for immediate revision to incorporate a section on the calculation of specific gravity and to change the title to "Density and Specific Gravity of Hydrocarbon Liquids by the Lipkin Bicapillary Pycnometer."

The Research Division on Analysis of Fuels recommended a revision for immediate adoption of the Standard Method of Test for Oxidation Stability of Gasoline (Induction Period Method) (D 525). A proposed method of test for determination of absolute water in petroleum products which represents a contemplated revision of Method D 95 was recommended for publication as information only as an appendix to the present standard. A cooperative test program on the filterability of jet fuels

## Committee Week Report

is now getting under way, and samples for tests are being distributed to the cooperators.

The Research Division on Volatility recommended a revision of the Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method) (D 323) to indicate in the scope that this method is intended for the determination of *absolute* vapor pressure of volatile nonviscose petroleum products, except liquefied petroleum gases. The Tentative Method of Test for Vapor Pressure of Liquefied Petroleum Gases (D 1267) was recommended for adoption as standard with revisions.

The Research Division on Corrosion recommended changes in the Tentative Method of Test for Free and Corrosive Sulfur in Petroleum Products (Copper Strip Test) (D 130) to cover improvements in the bomb design for neater closure and better manipulation. Also information will be added to the text of the method regarding the distinguishing between test strips 2 and 3.

The Subcommittee on Calorimetry submitted for publication as information only a Method of Test for Estimation of Heat of Combustion of Liquid Petroleum Products.

The Subcommittee on Graphite submitted a new Method of Test for Abrasiveness of Lubricating Graphite for publication as tentative. The Technical Committee on Cutting Fluids recommended for publication as information Methods of Test for Emulsion Stability of Soluble Oils.

The Subcommittee on Color submitted a revision of the Tentative Method of Test for Color of Lubricating Oil and Petrolatum by Means of ASTM Union Colorimeter (D 155). This revised method will include the 16 color glasses in place of the 12 now specified and it will be published as information as an appendix to the present Method D 155.

### D-3 Gaseous Fuels

Two subcommittees of Committee D-3 met during Committee Week.

The Subcommittee on Determination of Calorific Value of Gaseous Fuels gave detailed consideration to a number of changes in the ASTM Standard Method of Test for Calorific Value of Gaseous Fuels by the Water-Fow Calorimeter (D 900). This method is used for determining the total and net calorific values of fuel gases as purchased and sold commercially having total calorific values in the range from 300 to 3000 But per standard cu ft. The changes agreed upon at the meeting involve a revision and clarification of Section 20 on Reproducibility of Results. It was proposed to omit any requirement as to "maximum permissible differences"; to include a statement regarding the evidence available on reproducibility, and to point out the possible effect of extreme conditions of temperature, barometric pressure, and relative humidity. Extensive changes are to be made in that part of the method dealing with calibration of 0.1 cu ft wet test meter. This revision will bring Method D 900 into agreement with changes made recently in the Tentative Methods for Measurement of Gaseous Fuel Samples (D 1071) regarding calibration with a 0.1 cu ft bottle or calibration by the aspirator method. The revision will involve inclusion in Method D 900 of references to applicable sections of the current parts of Method D 1071.

The Subcommittee on Complete Analysis of Chemical Composition of Gaseous Fuels considered the advisability of revising the Tentative Method for Analysis of Carbureted Water Gas by the Mass Spectrometer (D 1302). The committee reviewed a number of proposed changes in these methods that had been received from members of Committee E-14 on Mass Spectrometry.

### D-4 Road and Paving Materials

The subject of effective specific gravity of aggregates for bituminous mixtures was selected for a symposium to be held at the 1956 Annual Meeting of the Society. It is felt there is considerable importance in obtaining more factual information on effective specific gravity of aggregates in connection with the engineering design of bituminous paving mixtures. At least six agencies are actively engaged in research on this subject. It was indicated that void determinations are complicated by the properties peculiar to the many types of aggregates used in bituminous pavements. The symposium will serve to collect the best of the existing information and assist Committee D-4 in the further work of standardization. A technical session will also be sponsored by the committee at the West Coast meeting of the Society, to be held in September, 1956, for which papers are planned dealing with the various phases of the technical activities of the committee.

Further advancement was made toward recognition of the Marshall and Hveem test procedures used in design of bituminous paving mixtures, in authorizing the publication as information and for comment of these two methods. A very great interest was shown in the work on the resistance of bituminous films to action of water. Data which are being used in statistical studies of the problem have been collected from many sources, particularly state highway departments. Action was taken on the continuation of a number of standards and tentatives under the jurisdiction of the committee.

### D-6 Paper and Paper Products

Committee D-6 held a well-attended meeting during TAPPI Week in New York on February 24 and 25, 1955.

A variety of problems were discussed involving re-evaluation of existing test methods due to faster operating speeds now incorporated in testing machines. Working groups were appointed to standardize speeds and tolerances of the crush tester, the wet bursting strength tester, and corrugated medium testers.

New areas of interest include mold proof testing methods, immersion tests for paperboard, and a quantitative test method for starch in paper.

The largest part of committee work is now involved with the revision of many of the existing D-6 standards in order that they may reflect the present state of paper technology.

### D-8 Bituminous Waterproofing and Roofing Materials

A review by Committee D-8 of all existing standards and tentatives under its jurisdiction resulted in various revisions, including a complete redrafting of the Method of Testing Asphalt Roll Roofing, Cap Sheets and Shingles (D 228). A consolidation of the Specification for Asphalt for Built-Up Roof Coverings (D 312) and the Specification for Asphalt for Dampproofing and Waterproofing (D 449) is being considered, with data to be circulated for later action. A number of standards were reaffirmed.

New fields of development were considered. A specification will be prepared for mineral surfacing materials for built-up roofs with a report expected at the next meeting. Branching out into the field of performance tests, Subcommittee IV on Membrane, Waterproofing, and Built-Up Roofing was requested to consider a method of sampling and testing built-up roofs. Progress was reported in defining the field of activity of the new Subcommittee on Rheological Properties. There was general agreement on the desirability of further elaboration of such general prop-

The committee also has in preparation a



several editorial changes for clarity.

program on the filterability of jet fuels

## Committee Week Report

erties as pliability or stiffness, cold flow, adhesion, and heat stability. Task groups will continue their investigations along these lines.

A special luncheon will be held during the Annual Meeting of the Society in Atlantic City to celebrate the 50th Anniversary of Committee D-8.

### D-11 Rubber and Rubber-Like Materials

One of the outstanding developments at ASTM Committee Week was the decision by Committee D-11 to establish immediately a new Subcommittee on Synthetic Elastomers. This action followed a report received from the operators of synthetic rubber plants recommending that six test methods for solid polymers, now published in the book of "Specifications for Government Synthetic Rubbers" under the Reconstruction Finance Corporation, Office of Synthetic Rubber, be established as ASTM standards.

A number of other actions important to the rubber industry were taken.

It was recommended that the National Bureau of Standards continue the practice of supplying standard chemicals for compounding materials. Operators of synthetic rubber plants will strongly recommend to the RFC, Office of Synthetic Rubber that a large amount of standard sample low-temperature low-polymerization rubber be scheduled for production during February or March. Each operator would then arrange transfer of a minimum of 30 bales to their respective inventories. A certain amount could also be transferred to the National Bureau of Standards as the 1955 standard sample. It was recommended that the assigned value, standard deviation, and range be determined by data from producing plant laboratories. It was also recommended that the National Bureau of Standards set up a standard rubber sample for 1956 and each year thereafter by purchasing such lots and determination of standards, preferably from an industry average.

The Committee proposed to enlarge its scope to include raw materials used in rubber manufacture. This change would bring Committee D-11 into the whole field of compounding materials.

Two interesting papers were given at the main technical meeting of the Committee: "Stress Relaxation of Vulcanized Rubber in Compression and Tension," by S. A. Eller, New York Naval Shipyard, and "Stress Relaxation of Non-Metallic Gasket Materials," by David R. Lem and John M. Reynar, Detroit Arsenal.

Discussion revealed much interest in the stress-relaxation characteristics of rubber which is important in many applications.

The Subcommittee on Protective Equipment for Electrical Workers reported that it had completed a revision of the American Standard Specifications for Rubber Insulating Sleeves (ASTM Designation: D 1051; ASA No. J6.5-1950) which after approval by letter ballot would be presented to Committee D-11 at its next meeting.

Proposed new Tentative Specifications for Ozone Resistant Insulating Tape were presented for committee letter ballot, covering high-voltage, ozone-resistant insulating tape designed for splicing electrical wires and cable operating at 2000 v and over, and for other insulating purposes.

The Subcommittee on Physical Testing recommended that an additional sketch of a mold by the cut-off bar method with a $\frac{3}{4}$-in. lower plate be included in the Tentative Methods of Sample Preparation for Physical Testing of Rubber Products (D 15). After considering the difficulties being encountered in evaluating the tensile properties of commercial "O" rings it was decided to form a task group to investigate the need for and, if necessary, to prepare test methods for evaluation of these materials. A paper on measuring and controlling of mill weld temperature during the mixing of various test batches was presented by G. E. Decker, of the National Bureau of Standards. Present standard equipment is considered unsatisfactory for close control and the newly designed Bureau of Standards mill roll has been found to be much more accurate.

The Subcommittee on Chemical Analysis received a report from a task group on trace metals. A new method for determination of iron in crude natural rubber or GR-S was presented for committee letter ballot. A progress report was presented on free carbon analysis in natural and synthetic rubber. This method which utilizes inert atmospheric pyrolysis of the sample is under study. The results to date indicate the need for more fundamental study before the method can be considered applicable to all rubber compounds. Progress reports by cooperating laboratories were presented covering studies of high-temperature combustion methods for sulfur analysis. The results so far give definite indication that this type of method will become useful and possibly quite accurate for rapid sulfur analysis.

The crude natural rubber subcommittee received a report on "Mooney Viscometer Cure Characteristics of Hevea Rubber: Results of an Interlaboratory Test" by G. E. Decker and John Mandel, of the National Bureau of Standards. This study which involved five cooperating laboratories led to the conclusion that this method is suitable for classifying natural rubber as to scorch and rate of cure. The subcommittee recommended that this report be submitted for publication in a future issue of the ASTM BULLETIN. A progress report was presented on results of some experiments conducted on blending smoked sheet by a Banbury mixer. From these tests it was concluded that if a lot of ten tons of rubber obtained from a single lot of blended latex from a single plantation did not have sufficient uniformity for use as a standard sample, it could be made sufficiently uniform by blending in the Banbury mixer.

An important revision in the Tentative Method of Test for Resistance to Accelerated Light Aging of Rubber Compounds (D 750) was presented for committee vote which will require that the temperature within the weather test apparatus be controlled by circulation of sufficient air to produce a black panel temperature of 145 ±5 F when measured by a standard-black painted panel with a suitable thermometer or thermocouple imbedded in the surface. The panel temperatures are to be taken in a position where the water spray is not striking the panel and at the point where maximum heat is developed due to light exposure.

A proposed Tentative Method of Test for Stress Relaxation of Vulcanized Rubber in Compression now ready for subcommittee letter ballot is the result of extended cooperative studies made during the past five years for determining this fundamental characteristic of rubber.

Further changes were agreed upon for the recently revised Tentative Methods of Test for Changes in Properties of Rubber and Rubber-Like Materials in Liquids (D 471) which involve modifying the test temperatures to conform to those in the Tentative Recommended Practice for Standard Test Temperatures for Rubber and Rubber-Like Materials (D 1349) for room temperatures and above. It was also decided to change the recommended immersion period of 30 days to "28 days."

## Committee Week Report

The latter seems more practical since it involved just four calendar weeks.

There was considerable interest in the subject of vinyl foam and similar materials. Consideration is being given to this subject by ASTM Committee D-20 on Plastics. An effort will be made to arrange a joint meeting of those interested in order to determine how best to proceed with the development of the test methods for these important materials.

The Subcommittee on Processibility Tests recommended the adoption as standard of the Tentative Method of Test for Plasticity and Recovery of Rubber and Rubber-Like Materials by the Parallel Plate Plastometer (D 926).

### D-16 Industrial Aromatic Hydrocarbons

The spring meeting of Committee D-16 was held in Roanoke, Va., on February 21, and 22, 1955.

During this meeting the subcommittees reported on the extensive collaborative work being accomplished by a large group of cooperating laboratories within Committee D-16 in the evaluation of suggested tests for various properties of naphthalene, pyridine, and quinoline. The most recently completed series was on the testing of phenol. In most cases the various suggested tests have been reduced to one for each property under consideration. These remaining tests will be subject to further collaborative examination before recommendations are made.

The results of the cooperative testing program for the proposed method of analysis of thiophene content was presented and variations in test results, due to individual laboratories using different types of apparatus, were discussed. Recommendations for the method will be presented.

A proposed method of test for orthoxylene, metaxylene, paraxylene, and ethylbenzene by ultraviolet spectrophotometry was presented for subcommittee review. A proposed method for testing isomer ratios by infrared methods is still in the early stages of study.

Committee work in thermometry has been one of vital interest, particularly considering the use of special thermometers in the distillation methods. For this reason a new subcommittee on thermometry has been established under the chairmanship of K. H. Ferber. The committee also felt the need for a subcommittee on statistics and approved its establishment under the chairmanship of W. J. Tancig.

### D-19 Industrial Water

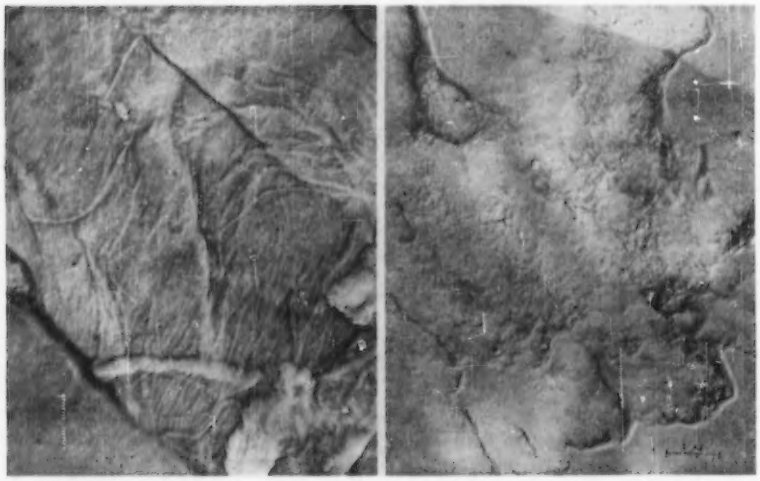
Significant progress was made on plans for a second edition of the Manual on Industrial Water. The first edition has been very well received, 3300 copies of the first and second printings having been sold in the last two years. Most of the present chapters will be extensively revised and others will be added, including material to cover the increasingly important field of industrial waste water. An outline of the material for the new edition has been substantially completed and preparation of the material for a new edition is now under way. It is expected that the second edition will be ready for publication in 1956.

Action was taken to recommend for adoption as standard the Methods for Examination of Water-Formed Deposits by Chemical Microscopy (D 1245); for Iodide and Bromide Ions in Industrial Water (D 1246), and for Reporting Results of Analysis of Industrial Water (D 596).

Revisions of the following 14 standards and tentatives relating to industrial water and industrial waste water were approved for committee letter ballot:

Definitions of Terms (D 1129)
Sampling Industrial Water (D 510)
Test for Chloride Ion (D 512)
Tests for Phosphates (D 515)
Test for Acidity and Alkalinity (D 1067)
Test for Sulfate Ion (D 516)
Test for Silica (D 859)
Test for Hardness (D 1126)
Test for Iron (D 1068)
Test for Fluoride Ion (D 1179)
Test for Chemical Oxygen Demand (D 1252)
Test for Sulfides (D 1255)
Test for pH (D 1293)
Specifications for Reagent Water (D 1193)

Several of the revisions are particularly significant. The revision of D 512 consists of a mercurimetric titration procedure that is sensitive enough for micro work but is applicable to all ranges of concentration of chloride ion normally found in industrial water. The revision of D 515 includes new



**Electron Micrographs of Untreated and Rosin Sized Experimental Hand Sheets (×25,000). Reduced for publication. Honorable Mention, Electron Micrographs—General, Ninth ASTM Photographic Exhibit. N. T. Woodberry, E. J. Thomas, M. C. Botty, American Cyanamid Co., Stamford, Conn.**

Both micrographs illustrate surface areas of individual cellulose fibers. The untreated fiber at the left shows characteristic fibrillar texture. In the sized fiber at the right the fibrils have apparently become coated with particles of aluminum rosinate sizing agent. A unique feature is the preparation of the replicas under pressure at room temperature directly from an intact hand sheet. Uranium shadowed.

the stress-relaxation characteristics of

sulfur analysis.

mersion period of 30 days to "28 days."

## Committee Week Report

gravimetric, volumetric, and colorimetric procedures to cover fully the analysis for phospates. D 1067 is being revised to cover industrial waste water as well as industrial water. D 510 is being revised to include sampling requirements for several newer tests not yet covered. D 1293 is being revised to cover all industrial water.

Preparations were made for an extensive cooperative testing program to be held in a large public utilities power plant for the purpose of comparing the accuracy of the six principal methods in current use for the dissolved oxygen determination. Tests for interferences and for the effect of various end-point indicators will be included in the program. As a result of the clinic, it is expected that important revisions will be made in the Methods of Test for Dissolved Oxygen in Industrial Water (D 888).

The committee recommended publication, for information only, of a comprehensive set of tests for optical properties of industrial water covering all important current instrumentation and techniques in this field.

Task groups were established to work on methods of tests for acidity and alkalinity and for phosphates in water supplies for use in the evaporative industry. It is intended that these methods, when approved by Committee D-19, will be submitted to The American Society of Mechanical Engineers for inclusion in the section on the Care of Power Boilers, of the ASME Boiler Test Code.

Of considerable interest to all concerned with the analysis of water-formed deposits will be the comprehensive scheme for analysis of such deposits which has been nearly completed for publication, agreement having been reached on all major points as a result of extensive cooperative tests reported on at the meeting.

A new subcommittee was set up to be responsible for all methods for physical or chemical testing of water or water-formed deposits wherein the specialized nature of the apparatus required is the controlling factor.

Work has been started on the development of test procedures for determination of the following in industrial water: hydrazine (which is a new and important dissolved oxygen scavenger), sodium and potassium by flame photometer, barium and strontium, lead, nickel, mercury, cadmium, silver, tin, zinc, volatile amines, and various emission spectroscopy procedures (including visual spectroscopy).

Development has also been started on procedures intended specifically for the determination of the following in industrial waste water: chromium compounds, specific gravity, oily matter by infrared and chromatographic techniques, mercaptans, residual chlorine, viscosity of sludges or slurries, and rate of separation of material that will settle or rise.

New task groups were established for determination of detergents in industrial waste water and for evaluating the effect of industrial wastes on the reproduction and growth of diatoms, which are sometimes used as an indicator of the health of a stream and therefore provide valuable information on the character of industrial wastes.

A task group was set up for development of various specific methods for performance tests of ion exchange resins for use in the treatment of industrial water.

### D-22 Atmospheric Sampling and Analysis

ASTM Committee D-22 on Atmospheric Sampling and Analysis will concern itself with problems of radioactive contamination of the atmosphere according to a decision reached at its two-day meeting, February 1 and 2, at Cincinnati, Ohio. It was agreed that the committee should confine its efforts to the sampling and analytical aspects of the problem leaving the interpretation of causes and effects to others. A representative of Committee E-10 on Radioactive Isotopes (J. L. Kuranz) has been appointed to advise Committee D-22 on Measurement of Radioactivity.

A highlight of the meeting was a visit of many members of the committee to the Robert A. Taft Sanitary Engineering Center of the U. S. Department of Health, Education and Welfare. Projects of the Center are concerned with both water and air pollution. Research directed toward better understanding and control of these conditions is being carried out by the Center.

Although there were no standards requiring action of the committee at the meeting, there are several in various stages of preparation by the subcommittees. Subcommittee I on Nomenclature and Units is developing additional definitions to supplement the list of about 75 previously submitted to the Standards Committee. Subcommittee II on Methods of Sampling is considering drafts of methods for stack sampling and for sampling gases, vapors, and particulate matter. Subcommittee III on Analytical Methods is submitting to subcommittee ballot a method for determination of fluorine in vegetation and biological materials, determination of nitrogen dioxide and determination of ozone.

### E-1 Methods of Testing

At the meetings of nine subcommittees and task groups of Committee E-1 plans were completed for two symposiums to be sponsored by the committee at the 1955 ASTM Annual Meeting to be held at Atlantic City, N. J., the week of June 26. The Symposium on Impact Testing which will comprise twelve technical papers will present a wealth of information on the current studies in industry of several new types of impact tests. One group of papers will be concerned with notched-bar impact with related methodology and geometry including information on reproducibility. The second group of papers will deal with impact testing and failure of parts and structures, and the significance of test.

The Symposium on Speed of Testing of Non-Metallic Materials will comprise eight papers dealing with speed effects and testing of a variety of materials including paper, plastics, wood and wood-base materials, impact of textile yarns, concrete, elastomers and hard rubber, clays, ceramics, and glass.

The Subcommittee on Calibration of Mechanical Testing Machines and Apparatus submitted revision in the Tentative Methods of Verification of Testing Machines (E 4) and Tentative Methods of Verification of Calibration Devices for Verifying Testing Machines (E 74). In Method E 4 the paragraph on Basis of Verification is revised to read as follows:

> At the lower limit of the loading range the algebraic difference between the highest and the lowest percentage error of the five test loads shall not exceed 1.0.

Revisions are also being made in both Methods E 4 and E 74 to permit the verification of testing machines by means of equal-arm balances and standard weights.

The Subcommittee on Elastic Strength of Materials approved for submission to letter ballot a proposed new Tentative Method for the Determination of Young's Modulus at Room Temperature. The precision desired in determinations of Young's modulus is usually of a higher order than that required in other tests, the over-all precision being of the order of the tolerances permitted in a single variable in other tests. Some of the most important variables are accuracy of load, accuracy of extensometer, orientation of crystals, residual stress, previous strain

## Committee Week Report

history, dimensions of specimen, eccentricity of specimen, condition of testing equipment, alinement of specimen, speed of testing, temperature, temperature variation, interpretation of data, stress range, and strain range.

Action was taken to enlarge the membership of the Task Group on Review of Definitions, of Subcommittee 3, in order to include representatives from the technical committees on nonmetallic materials in addition to the present representatives of the metals committees. This task group will be responsible for a further review of the recently revised Tentative Definitions of Terms Relating to Methods of Mechanical Testing (E 6).

The Subcommittee on Tension Testing appointed a task group to give consideration to definitions of terms used in connection with tension testing. This will involve review of the terms now appearing in the Tentative Definitions of Terms Relating to Mechanical Testing (E 6), the Tentative Methods of Tension Testing of Metallic Materials (E 8), and the Tentative Methods and Definitions for the Mechanical Testing of Steel Products (A 370). Attention of the committee was called to the matter of length of the ends of tension specimens, especially for specimens used in the testing of the thicker and the high-strength materials. It was agreed that a review should be made of the types of grips being used for various capacities of testing machines, especially those in the higher ranges up to 400,000 lb capacity. An extensive survey of tension test specimens completed by the Department of the Army, Office of the Chief of Ordnance, will also be reviewed during the year.

The Subcommittee on Indentation Hardness Testing reported completion of a new Method of Test for Indentation Hardness of Metallic Materials by Means of Portable Hardness Testers which, after approval by letter ballot vote, will be submitted to the main committee as tentative. The present Standard Methods of Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (E 18) were reviewed in detail and extensive editorial rearrangement of these methods in order will be undertaken to improve the manner in which the details of the test procedure are presented.

The Task Group on Bend Testing reviewed at its meeting definitions relating to bend tests. These included the following general definition:

*Bend Test.*—A bend test is a test performed by bending or folding, usually by steadily applied forces, but in some instances by blows, a specimen of substantially uniform cross-section over a length several times as great as its width, thickness, or diameter. In the scope of these definitions the bend test is a test of ductility. The ductility is usually judged by whether or not the specimen cracks under specified conditions of the test. The force required to make the bend is not a datum of the test and usually is not measured.

There are four general types of bend tests according to the manner in which the forces are applied to the specimen to make the bend: (1) free bend, (2) semiguided bend, (3) guided bend, and (4) wrap-around bend. Definitions for these individual types of bend tests were also prepared including descriptions of such terms as angle of bend, radius of bend, and pin or mandrel. The definitions as revised at the meeting will be submitted to letter ballot for inclusion in the Tentative Definitions of Terms Relating to Methods of Mechanical Testing (E 6).

The Subcommittee on Low-Temperature Testing of Elastomers and Plastics received an interesting progress report of the studies being made to obtain brittleness temperature data on samples of the compositions used in earlier studies of hardness and stiffness. These latter studies were reported recently in two papers published in the ASTM BULLETIN: "A Study of Stiffness Testing of Elastomers at Low Temperatures," by F. S. Conant, ASTM BULLETIN No. 199, p. 67, and "A Study of Hardness Testing of Elastomers at Low Temperatures," by B. G. Labbe, ASTM BULLETIN No. 199, p. 73. A report was also received from the Task Group on Correlation of Bureau of Ships reports. This included the results of the recent round-robin on preliminary standardization of hardness test instruments and cold boxes.

### E-4 Metallography

Definitions of terms relating to metallography have been under intensive review for several years. The ASTM document covering these terms is E 7 which was last revised in 1927. Since that time many new branches of metallography have developed, such as electron microscopy. This project reached fulfillment early this year and it is hoped that the revised and tremendously expanded definitions can be approved by the Society for publication in 1955.

It now appears that agreement is only a matter of months away for a universal grain size standard. This standard would cover untwinned grains of all metals, ferrous and non-ferrous. After decades of diversity, metallurgists are approaching the understanding that a grain is the same whether it be in steel, nickel, aluminum, copper, or any other metal or alloys.

### E-5 Fire Tests of Materials and Construction

Additional coverage in the field of fire tests will now be provided with the acceptance by the committee of a new tentative method of fire tests of roof covering, subject to confirming letter ballot. This method has been under consideration for some time with coordination with the Asphalt Industry Bureau.

A complete revision of the Standard Methods of Fire Tests of Door Assemblies (E 152) was accepted at the meeting. These revisions include further refinements in test procedure and in the method of reporting results. It will also be recommended that the standard be reverted to tentative status.

The committee approved a recommendation to adopt as standard tentative revisions now published for Standard Methods of Fire Tests of Building Construction and Materials (E 119). These revisions relate to the arrangement of the thermocouples, information in the report, and the deletion of the section on test structures. A further revision was accepted for immediate adoption involving the thermocouples used for establishing the furnace temperatures.

Development of a specification of tests of nonbearing partitions in which the limiting temperature end point is omitted or increased was considered but the committee did not think such a specification was needed.

The method of test for defining noncombustibility of materials is about in final form to be submitted to the committee for possible action at the next meeting.

A progress report was presented on the research program at the Forest Products Laboratory involving the use of the small tunnel test. The test program has reached a point where a matched set of samples tested in the large tunnel apparatus at the Underwriters' Laboratories will now be tested in the small tunnel apparatus. A new development in flame spread testing apparatus was described. This involves the use of a revised version of the British radiant panel test apparatus. This work is being conducted at the National Bureau of Standards and the results of this program will be awaited with considerable interest by Committee E-5, as well as other ASTM materials

committees interested in this type of evaluation test.

## Committee Week Report

### E-7 Non-Destructive Testing

Reference radiographs for steel welds have been approved by the committee and are expected to be approved by the Society for publication at an early date. The reference radiographs will be in the form of negatives centered in Keysort cards. The Keysort cards will be coded for hand sorting operations. By using Keysort cards it is expected that more reference radiographs can be offered for sale at later dates without destroying the effectiveness of the original set.

### E-9 Fatigue

At its meeting Committee E-9 reviewed its plans for a Symposium on Fatigue which will be held at the Society's Annual Meeting in June. Twelve papers are now being processed and there are possibilities for several more. Two sessions on fatigue seem assured at this time with possibly a third joint session.

At present the committee is working on a report of the status of spectrum loading of aircraft structures, research in the fundamental field of fatigue, and statistical methods. Information will be obtained on an ultrasonic attenuation device which is being proposed as a means of detecting fatigue damage.

### E-10 Radioactive Isotopes

Several aspects of radioactive tracer techniques are being developed as possible ASTM methods or recommended practices. Committee E-10 has noted with interest that some ASTM committees are cognizant of the potentialities of radioisotopes in testing materials (notably Committee D-1 on Paint, Varnish, Lacquer, and Related Products; Committee D-18 on Soils for Engineering Purposes; and Committee D-19 on Industrial Water) and has offered its services in helping to develop suitable test methods.

At the meeting on February 2, three papers were given before the committee as follows:

Measuring Traffic Paint Abrasion with Beta Rays—Bryant W. Pocock, Michigan State Highway Department

High Resolution Autoradiography—Henry J. Gomberg, University of Michigan.

"Effects of Radiation on Materials," V. P. Calkins, General Electric Co.

The committee has appointed C. E. Crompton, U. S. Atomic Energy Commission, Oak Ridge, to organize a symposium for the West Coast meeting of ASTM in September, 1956. A meeting of the committee is also tentatively planned at the same time.

### E-12 Appearance

Committee E-12, its Advisory Committee, and four subcommittees met in Roanoke, Va., on February 22 and 23. The Subcommittee on Definitions held a joint meeting with Group S, of the Subcommittee on Optical Properties, of Committee D-1 on Paint Materials. It was decided to issue as tentative the ASTM Terminology and Geometric Conditions of Measurement for Light Reflectance and Transmittance of Objects and Materials. The text is to be rearranged to add emphasis to problems of selection as well as identification of reflectance and transmittance scales. After inclusion of these and other changes, it will be submitted to committee letter ballot.

The Subcommittee on Color and Spectral Characteristics received a progress report on color difference measurement and specification. Nineteen observers have made visual estimates of color differences on the paint panels submitted by the Subcommittee on Optical Properties, of Committee D-1. Six more observers are planning to make visual estimates of color difference using these panels. Visual estimates are also being made on a series of porcelain panels, prepared by the Porcelain Enamel Inst. Color differences have been calculated on the basis of the McAdam data, and some correlation diagrams have been prepared. A tentative report is expected to be available at the June meeting.

Description of a method for measurement and specification of color by spectrophotometry, prepared for Federal Specification TT-P-141b, was presented for review and comment by the committee.

Consideration is being given to methods for total reflectance measurements. The technical committees of the Society interested in this subject will be consulted in developing a program of work.

A proposed Method for Goniophotometry (Angular Light Reflectance and Transmittance of Objects and Materials) was recommended for publication as information.

The Tentative Method of Test for 45-deg, 0-deg Directional Reflectance of Opaque Specimens by Filter Photometry (E 97) was recommended for adoption as standard with revisions in the scope to indicate that the method is applicable to the testing of ceramic whitewares in addition to porcelain enamel.

A program of work was planned to undertake comparison of panels for goniophotometer measurements. Three panels in each set are to be measured for light reflectance with light incident at 45 deg. The Subcommittee on Pictorial Representation is reviewing the various standards, established by ASTM technical committees, which involve the use of different types of pictorial reference standards. Of particular interest to this subcommittee was the talk on "Depth Perception in Color Photography" presented by Ralph M. Evans, Eastman Kodak Co.

The committee has submitted to the Administrative Committee on Research descriptions of the following two projects for inclusion in "Some Unsolved Problems": (1) Color Measurements of Turbid and Translucent Materials; (2) Material Standards for Color, Gloss, and Transparency.

## Automation Symposium at Michigan State Centennial

AUTOMATION — Engineering for Tomorrow is the title of one of the ten symposiums planned this year to celebrate the 100th anniversary of the founding of Michigan State University.

Scheduled for May 13 and 14 under the chairmanship of Prof. J. M. Apple, the programs will be built around a series of general sessions of interest to all branches of engineering and a concurrent series of meetings to be sponsored by individual departments of the school.

Among the speakers will be W. R. G. Baker, Vice-President, General Electric Co., and Eric A. Walker, Dean of Engineering, Pennsylvania State University. Dr. Baker will look at automation from a technical point of view and Dean Walker will discuss it from the philosophical or sociological point of view. Topics for discussion at the general sessions are: Automation—To Date; Automatic Control Systems; Design of Systems; and Instrumentation of Automation.

# Proposed Specification for Packaged, Dry, Combined Materials for Mortar and Concrete

ED. NOTE.—The marketing of small quantities of dry concrete and mortar mixes in packaged form has increased to the extent that this product is now available throughout the country and can be found on the shelves of most hardware and building supply houses. This product has proven very popular and useful, not only to the small "do-it-yourself" consumer, but in considerable volume to public works departments and maintenance departments of housing and other building agencies.

Recognition of the need for establishing a quality material by ASTM Committee C-9 on Concrete and Concrete Aggregates, resulted in the organization of Subcommittee III-q on Methods of Testing and Specifications for Packaged, Dry, Pre-Mixed Materials for Mortars and Concrete. It was evident that the preparation of small quantities of concrete or mortar mix required very careful, as well as special, means of handling and control. This specification has attempted to set up requirements covering the handling of the individual materials used in the product, the packaging of the materials, and, of course, setting up of physical requirements, such as strength, of the resulting concrete or mortar.

This new type of ASTM Specification is being published as information only before recommendation to the Society as a new tentative, in order to solicit comments. These comments should be addressed to the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.

### Scope

1. This specification covers the production, properties, and packaging of dry, combined materials for (*a*) concrete, (*b*) concrete mortar, and (*c*) mortar for use with unit masonry.

### Basis of Purchase

2. The purchaser shall specify either concrete, concrete mortar, or masonry mortar; the physical requirements for either as prescribed in Table I shall govern.

### Materials

3. Materials used as ingredients in packaged, dry, combined materials for mortar and concrete shall conform to the following requirements:

(*a*) *Cementitious Materials.*—Cementitious materials shall conform to the following specifications of the American Society for Testing Materials:

(1) *Portland Cement.*—Type I, II, or III of the Specifications for Portland Cement (ASTM Designation: C 150)[1], or type IA, IIA, or IIIA of the Specifications for Air-Entraining Portland Cement (ASTM Designation: C 175).[2]

(2) *Masonry Cement.* Specifications for Masonry Cement (ASTM Designation: C 91).[1]

(3) *Hydrated Lime.* Type S of the Specifications for Hydrated Lime for Masonry Purposes (ASTM Designation: C 207).[2]

(*b*) *Aggregates.* Specifications for Aggregates for Masonry Mortar (ASTM Designation: C 144),[2] Specifications for Concrete Aggregates (ASTM Designation: C 33),[2] and Specifications for Lightweight Aggregates for Structural Concrete (ASTM Designation: C 330).[1]

### Preparation of Aggregate

4. (*a*) All aggregates shall be dried, without disintegration, to a moisture content less than 20 per cent of total absorption, as determined by the Methods of Test for Specific Gravity and Absorption of Coarse Aggregates (ASTM Designation: C 127),[2] and for Fine Aggregate (ASTM Designation: C 128).[2]

(*b*) All aggregates shall be introduced into the packages at a temperature between 130 and 170 F.

### Proportioning

5. (*a*) The materials incorporated in each package of dry combined concrete shall be so proportioned as to produce a 2- to 3-in. slump as determined by the Method of Test for Slump of Portland-Cement Concrete (ASTM Designation: C 143)[2] when mixed with the quantity of water indicated on the package and shall conform to the physical requirements in Table I.

(*b*) Packaged, dry, combined concrete mortar shall be proportioned so as to meet the physical requirements in Table I.

(*c*) Packaged, dry, combined mortars for unit masonry shall conform to the type M, S, or N mortar prescribed in Table I of the Specifications for Mortar for Unit Masonry (ASTM Designation: C 270)[3] and shall meet the water retention requirement in Section 6 of Specifications C 270.

### Physical Requirements

6. Packaged, dry, combined materials for concrete, concrete mortar, and mortar for use with unit masonry shall conform to the respective physical requirements prescribed in Table I for the material specified.

### Packaging and Marking

7 (*a*) Package sizes shall be based on yield in cubic feet or in square feet for a given thickness computed on a volume basis of cement, aggregate, and water, as suggested in Table II.

(*b*) *Container Construction.*—The container in which concrete materials are packaged shall be a sewn multiwall paper bag of the open mouth type. Packages containing materials to yield 1/2 cu ft or more shall be constructed of 3-ply (two 50-lb sheets and one 40-lb sheet) of Kraft paper and 1-ply of a moisture-repellent sheet, equivalent to a 90-lb asphalt-laminated sheet. All other package sizes shall be constructed of two 50-lb Kraft sheets and one 90-lb asphalt-laminated sheet or equivalent.

[1] 1953 Supplement to Book of ASTM Standards, Part 3.
[2] 1952 Book of ASTM Standards, Part 3.
[3] 1954 Supplement to Book of ASTM Standards, Part 3.

TABLE I.—PHYSICAL REQUIREMENTS.

| Kind of Material | Water Retention min, per cent | Compressive Strength, in min, psi | | | |
|---|---|---|---|---|---|
| | | 1 day | 3 days | 7 days | 28 days |
| Mortar for unit masonry | 70.0 | ... | ... | ... | 750 |
| Concrete mortar | .. | ... | ... | 3 000 | 4 000 |
| Normal strength concrete | .. | ... | ... | 2 500 | 3 500 |
| High early strength concrete | .. | 1 500 | 2 500 | ... | ... |
| Lightweight concrete (using natural sand) | .. | ... | ... | 2 000 | 3 000 |
| Lightweight concrete | .. | ... | ... | 2 000 | 2 000 |

### Sampling

8. An unopened package of dry, combined material shall constitute a sample. The contents of the package shall be emptied upon a clean, non-absorbent surface and mixed manually. After mixing until the contents appear uniform, material sufficient for a specific test shall be obtained by dipping a small quantity from different points selected at random.

### Methods of Test

9. (*a*) *Water Retention.*—The water retention test on mortar for unit masonry shall be made in accordance with Section 30 of the Specifications for Masonry Cement (ASTM Designation: C 91).[1]

(*b*) *Compressive Strength of Mortar.*—The compressive strength test of mortar for unit masonry and of concrete mortar shall be made in accordance with the Method of Test for Compressive Strength of Hydraulic Cement Mortars (ASTM Designation: C 109),[2] except that the mortar shall be mixed to a flow of 85 to 95 per cent after ten ½-in. drops one a 10-in. flow table as specified in Specifications for Flow Table for Use in Tests of Hydraulic Cement (ASTM Designation: C 230),[2] and that cubes made of mortar for unit masonry shall be cured as described in Section 8(*b*) Item (*2*) of Specifications C 270.[3]

(*d*) *Compressive Strength of Concrete.*—The compressive strength test of the concrete shall be performed on 6 by 12-in. cylinders made with the material mixed to a slump of 2 to 3-in. The cylinders shall be made and cured as described in the Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory (ASTM Designation: C 192)[2] and tested as described in the Method of Test for Compressive Strength of Molded Concrete Cylinders (ASTM Designation: C 39).[2]

TABLE II.—SUGGESTED PACKAGE SIZES.

| Mixture | Weight, min, lb | Yield, cu ft[a] | Yield, sq. ft per in. thickness[a] |
|---|---|---|---|
| Concrete | 90 | ⅘ | 8 |
| | 45 | ⅖ | 4 |
| | 22½ | ⅕ | 2 |
| Concrete mortar | 80 | ⅘ | 8 |
| | 40 | ⅖ | 4 |
| | 20 | ⅕ | 2 |
| | 10 | 1/10 | 1 |
| Lightweight concrete plus natural sand | 60 | ⅘ | 8 |
| | 30 | ⅖ | 4 |
| Lightweight concrete | 50 | ⅘ | 8 |
| | 25 | ⅖ | 4 |

[a] The yield in cubic feet, the yield in square feet per inch of thickness, and the amount of water required for mixing shall be marked on the package.

### Inspection

10. The following period from time of sampling shall be allowed for completion of testing:

| | |
|---|---|
| 1-day test | 6 days |
| 3-day test | 8 days |
| 7-day test | 12 days |
| 28-day test | 33 days |

### Basis of Rejection

11. (*a*) The packaged, dry, combined materials may be rejected if they fail to meet any of the requirements of these specifications.

(*b*) Packaged, dry, combined materials remaining in storage for more than 6 months after completion of tests should be retested before use and may be rejected if they fail to conform to any of the requirements of this specification.

(*c*) Packages varying more than 5 per cent from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

(*d*) All unsealed packages may be rejected.

## Cover Color Standardization?

FROM reports received at Headquarters, readers seem to like the different colors used on the cover of the BULLETIN each issue. It helps to distinguish one from another at a glance. No claims for originality are made for this feature of the BULLETIN and it is known that other publications are similarly decorated.

A sister publication can claim distinction as the first (?) to approach scientific standardization of the cover color. The following is quoted from Vol. 4, No. 9 (1954) of the *Capital Chemist*, publication of the Washington, D. C., section of the ACS:

"***Retrospectrum***—This issue completes the year's total of nine vari-colored numbers of THE CAPITAL CHEMIST. The bright hues on our covers—dividends from modern printing art—have from the early days of the publication served as attractive adjuncts to the material contained within. This year something new has been added: a certain order and selection in the color series. If the issues for the year are arranged in chronological order, and displayed vertically to expose a portion of each cover, a spectrum or its reasonable facsimile will be observed (and this at no extra charge to subscribers!).

"From a practical viewpoint, a natural association of colors with seasons suggests that the spectrum may serve as a visual index in referring to past copies. The violet and blue are definitely associated with the winter months, blue-green and green with St. Patrick's Day and springtime, yellow with May and summer, while autumn sees the emergence of the deep yellow and orange, and finally the year ends in the red—but for Christmas, not for our financial state."

For the technically minded, *The Capital Chemist* then listed the dominant wavelengths for recognized points in the spectrum and those corresponding to its 1954 covers and then continued:

"After a poor start in January with a bluish-purple instead of blue-violet, the spectrum improved through the year. The approximate dominant wave lengths for the cover were determined by Dr. Deane B. Judd, National Bureau of Standards, who some years ago prepared the popular NBS Letter Circular LC-454 on 'Hues of the Spectrum Color.' We will try again next year; perhaps with the continued fine cooperation of our printer, our aim will be a little closer and we may even approach a series of color standards."

# Court Decision Favors Corporate Grants for Research....

## Engineering Foundation Can Benefit

DURING the past year an important decision regarding the right of boards of directors of corporations to make contributions of corporate net earnings to the support of charities, education, and research has been handed down by the courts. Previously, there had been implications that corporations must secure direct authorization at stockholders' meetings before any such contributions could be made unless it could be demonstrated that the purpose of the grant had a direct connection with the immediate future earnings of the corporation. These implications have now been largely removed and the lower court decision has not been appealed to any higher court.

Management of corporations can now more easily make contributions in those areas of public service in which it has been increasingly difficult to obtain financing from other sources. Not only will the colleges, universities, and charitable organizations benefit from this court approval of corporate social consciousness but also will many worthy foundations which obtain their support largely from private or corporate donations.

For Engineering Foundation, this court decision offers a new field of possible activity. For larger corporations the 5 per cent allowable deductions under the corporation income tax laws for charity, education, and research are of a magnitude to justify a reasonable expense for investigating carefully, potential grants that may be contemplated from these funds. But for a host of smaller corporations, partnerships, or individuals, the expense of evaluating all potential grants would be rather high. To such organizations, contributions can be made to the Engineering Foundation with assurance to the donor that grants will be carefully screened by competent reviewing committees and that the funds will be applied to worthy projects.

### Foundation Completes Fortieth Year

Engineering Foundation was established in 1914 for the four major engineering societies—American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers—to administer an endowment fund provided by Ambrose Swasey "for the furtherance of research in science and engineering and for the advancement in any other manner of the profession of engineering and the good of mankind." Since 1914, substantial additions have been made to the original endowment by engineers or their estates and by one industrial company. Under the terms of its charter, Engineering Foundation expends the income only from its endowment fund in the furtherance of these objectives. It receives no financial return from projects that it supports.

During the early years of the Foundation, there was a very close working relationship with the National Research Council which had been established at about the same time by the National Academy of Sciences. For a time during 1916, both organizations occupied the same offices in the Engineering Societies Building in New York City. As financial support of the National Research Council increased, the two organizations became more independent, and the relationship of the Engineering Foundation became closer to the Division of Engineering and Industrial Research of the National Research Council than to the Council itself.

From 1919 to the end of 1922, the Foundation supplied between $10,000 and $11,000 a year to support the Division. The Foundation developed into an instrumentality to encourage, organize, and support research in engineering and progress in engineering education aided by liberal industry grants, and the NRC became an organization to correlate research and encourage cooperation between Government agencies in engineering fields and engineers in industry and universities and to advise the Government on technical and scientific matters. During the past 20 years, the Division of Engineering and Industrial Research of the National Research Council has greatly expanded the number of its affiliated societies and its membership so that at present the Foundation and the Founder Societies are represented by only five out of forty-four members of the Division, and the Founder Societies are only four of the twenty-two professional and technical groups cooperating with the Division. An article on the NRC appeared in the February, 1954, issue of the BULLETIN, page 18.

### ASME–ASTM Project Supported

In 1930, when the ASME-ASTM, Committee on the Effect of Temperature on the Properties of Metals made its first major appeal to industry for funds, the Foundation offered its support. Research on this subject, support for which was begun by the joint committee in 1924, is continuing at the present time. A total of over $220,000 has been expended of which about 10 per cent was contributed by Engineering Foundation.

Many other worthy research projects have been catalyzed by partial support by the Foundation. It has been a policy of the Foundation to provide major support for new projects only in initial stages until such time as findings from the project arouse the interest of others toward providing support. In this way the Foundation has been able to influence the allocation of research funds by others in amounts greatly exceeding the Foundation contributions. Important projects to which the Foundation has contributed include: ASME project to extend the then current steam tables (1922); ASCE project on concrete arches and arch dams (1922); AIME project on blast-furnace slags (1926); and in the same year a five-year project on dielectrics with AIEE was begun. Other projects initiated in the 1920's and still active include ASME investigations of lubrication (1923), and on fluid flow and fluid meters (1927).

During the 1930's a number of research projects were organized, sponsored, and supported by the Foundation and in many cases also by industry despite the depression. Among these the following may be mentioned: soil mechanics, hydraulics, and plastic flow of concrete by ASCE; barodynamic research by AIME; cottonseed processing, boiler feed water, metal cutting, and plastic flow by ASME; and paper insulation by AIEE. Also established during the depression were the still active Welding Research Council and the important ASME work on high-temperature steam generation.

### Advancement of Engineering Profession

Although the principal activity of Engineering Foundation is the sponsorship and support of engineering research,

another major activity is to sponsor projects for the advancement of the engineering profession. One such project, jointly with American Society for Engineering Education, was on evaluation of engineering education. The final report on this project was prepared by the ASEE Committee and presented in June, 1954. This final report was termed an "interim report" because the committee felt that further studies were necessary to evaluate graduate study in engineering.

Some of the other such projects active during the Foundation's 40-year history were: Industrial Personnel Problems, Engineering Aptitudes, Employer-Employee Cooperation, and Simplification of Scientific Literature Searches. In addition, support was provided for various publications including Applied Mechanics Reviews (continuing) and textbooks on Strength of Metals and Fluid Dynamic Problems.

### Column Research, a Current Project

The American Society of Civil Engineers has established four research councils on various problems in civil engineering. These groups now have adequate financial support, and Foundation support is only a token plus an occasional additional grant for the solution of some special problem. The four Research Councils are concerned with Riveted and Bolted Structural Joints, Reinforced Concrete, Wave Research, and Column Research. Each of these groups supervises a number of research projects at various universities. The Column Research Council is concerned with design problems on columns, the basic load-bearing members of most structures. Columns have long been designed by formulas based on tests on small structures; application of these formulas to columns used in large modern structures is not completely justified on a basis of available data, and it is to improve the design information on structural columns that is the main objective of the council.

The Foundation contributes to four projects of the AIME: Alloys of Iron Research, Quenching Investigations, Diffusion in Steel, and Comminution. All these projects are concerned with metallurgy and the one on comminution is particularly interesting. Comminution or mechanical size reduction of brittle materials is one of the most important operations in industrial metallurgy. Investigations of fracture phenomena and energy changes in comminution provide a fertile field for research and findings are useful in practical comminution operations.

In cooperation with ASME, the Foundation contributes to seven projects, including several previously mentioned and others on high temperature steam, properties of gases, mechanical pressure elements, and heat conduction charts. Of particular interest to materials engineers is the project on high-temperature steam generation for which the principal objective is to determine performance characteristics of selected ferritic or austenitic alloys when exposed to the action of steam and to the products of combustion at temperatures higher than those now encountered in modern power plant operation. Four factors are being investigated: (1) the nature, thickness, permanence, and thermal conductivity of the oxide film on surfaces swept by steam at temperatures between 1100 and 1500 F; (2) the resistance of selected alloys to the products of combustion of typical fuels; (3) the metallurgical stability of the alloys over long periods, and (4) the effects of repetitive temperature shock.

The Foundation is continuing support for the Engineers' Council for Professional Development and the Welding Research Council. Also two independent projects receive contributions from the Foundation. These include the Building Research Advisory Board of the National Research Council and a project at Massachusetts Institute of Technology entitled "Causes and Methods of Prevention of Corrosion of Water Pipes." A recent activity of the Building Research Advisory Board in sponsoring a conference on Plastics in Building was reported in the January issue of the ASTM BULLETIN, page 73.

## Graduate Plastics Program Fellowships

PRINCETON UNIVERSITY offers an engineering curriculum of graduate study and fundamental research in plastics leading to the degree of Master of Science in Engineering particularly suited to chemical, electrical and mechanical engineers, and to chemists and physicists.

Instruction covers properties, evaluation, production, fabrication, design, and application of materials, as well as chemistry of plastics. The program includes lecture and laboratory classes, and contact with industrial plants representing various interests of the plastics industry.

Fellowships with stipends of from $1500 to $2100 plus tuition and fees are available. Opportunities for employment as half-time Research Assistants at $1500 per academic year are also available to students not on fellowships.

Applicants for admission must hold a bachelor's degree in engineering or physical science from a recognized institution and must meet general admission requirements of the Graduate School of Princeton University.

For further information, address: Louis F. Rahm, Director, Plastics Laboratory, 30 Charlton St., Princeton, N. J.

## Textile Committee Award to John H. Dillon

JOHN H. DILLON, Director, Textile Research Inst., Princeton, N. J., was the sixth recipient of the H. De Witt Smith Memorial Medal from ASTM Committee D-13 on Textile Materials.

The medal was presented to Dr. Dillon at a luncheon held in his honor on March 17 during the spring meeting of Committee D-13 at the Statler Hotel, New York City.

The medal, made possible by the generosity of Fabric Research Laboratories, Inc., Boston, is a tribute to the memory of H. De Witt Smith who pioneered in the concept of an engineering approach to the evaluation of the properties of textile fibers and to their utilization. It is awarded at intervals of not less than one year by Committee D-13 for outstanding achievement in research on fibers and their utilization.

Dr. Dillon, who received his Ph.D. degree from the University of Wisconsin, was appointed Director of Research of Textile Research Inst. in 1946 and Director of the Institute in 1951. He is the author of many publications in both the rubber and textile fields and holds a number of American and foreign patents.

Previous recipients of the award have been Herbert F. Schiefer, Edward R. Schwarz, Frederic Bonnet, Herbert J. Ball, and A Griffin Ashcroft.

## Textile Research Congress

IN CONJUNCTION with the Second International Textile Exhibition which will be held in Brussels June 25-July 10, Centre Scientifique et Technique de l'Industrie Textile Belge is scheduling an International Congress of Scientific Research Applied to the Textile Industry, June 27–29.

The technical program of the Congress will include three major lectures and communications from textile research men all over the world.

Reservations and further information can be obtained from the Center, 24 Rue Montoyer, Brussels, Belgium.

# Random Samples . . .

## FROM THE CURRENT MATERIALS NEWS

*From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.*

### Mummy Paper

DURING the Civil War, papermaker I. Augustus Stanwood was pressed for raw material to keep his Maine mill in operation. He used his ingenuity to overcome the difficulty. This he did by importing mummies from Egypt for the sole purpose of stripping the dried bodies of their cloth wrappings and using the material for making paper. Stanwood brought several shiploads of mummies to his mill in Gardiner, Me., and threw the woven wrappings as well as the papyrus filling into the beaters. He manufactured from these substances a coarse brown wrapping paper, which eventually found its way into the shops of grocers, butchers, and other merchants who used paper of this kind.

The rags stripped from the long-dead Egyptians caused an epidemic of cholera among the rag pickers and cutters in the Maine mill, for at that period there was no regulation regarding the disinfection of rags.

The only competition that Stanwood encountered in purchasing the mummies was the Egyptian railroad, for during a ten-year period the locomotives of Egypt made use of no other fuel than that furnished by the well-wrapped, compact mummies, the supply of which was thought at the time to be almost unlimited.

●

### Copper Drainage Tube Announced

WIDESPREAD interest is expected to be aroused among architects, engineers, builders, contractors, plumbers, and building officials by the new copper tube series announced by the Copper and Brass Research Assn.

To be known as copper drainage tube, the new product is expected to furnish the ideal material for use in soil, waste, and vent lines in modern plumbing systems. Following a comprehensive investigation by the Association and copper tube fabricators, copper drainage tube was scientifically developed specifically for sanitary drainage service. It will provide important economies for all types of building construction and, at the same time, assure a permanent installation due to the corrosion-resistance properties of copper.

Research tests have shown that copper drainage tube will provide trouble-free service for the life of a building in normal applications. Fabricators of copper tube are commencing production of the new product.

●

### Hot Clothes

AN ALUMINUM-COATED fabric, for use in protective garments for industrial "hot jobs," is now being manufactured by Minnesota Mining and Manufacturing Co. Protecting the wearer by reflecting radiant heat, instead of insulating against it, the new material is flexible and weighs half as much as other protective fabrics, thus giving the wearer more freedom to work.

Field tests showed that the new fabric gives workers better protection, allowing them to work in the heat for longer periods of time; molten splatter rolls off the garment instead of collecting and adding weight; it wears longer than other protective materials; it has been accepted by "hot job" workers because of the freedom it allows. Men wearing face shields, aprons, and spats of the aluminized fabric changed doors on a furnace operating at 2100 F. In another plant, steel furnace repairs and maintenance were made without completely shutting down the equipment and waiting for it to cool. A scarfing operation, which because of the intense heat previously required two men to work alternately, was accomplished regularly by one man.

●

### Cookbook on Titanium

TO HASTEN the development of titanium technology, the U. S. Department of Commerce's Office of Technical Services has made available to industry a comprehensive reference work on the characteristics of some 70 titanium alloy systems, including phase diagrams and crystal structures. This information was compiled by Battelle Memorial Inst. for the Wright Air Development Center, and comes from many sources, both published and unpublished. The material represents information available as of March, 1953, and the presentations are standardized in every way possible for ease of comparison of all the systems.

The phase diagrams presented in this volume will be particularly valuable to metallurgists in anticipating and solving problems in titanium alloy manufacture and heat treatments.

PB 111508, Constitution of Titanium Alloy Systems. 1953. 261 pages, with charts and isothermal sections. $8. Order from OTS, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to the Office of Technical Services.

●

### Aluminum Scores Again

AIR-COOLED aluminum automobile wheels and aluminum tanks for hot water heaters are two new outlets for the aluminum industry.

The 1955 Cadillac Eldorado has as standard equipment forged all-aluminum spoke wheels, which permit air to flow through and cool the brake drum. These wheels are also optional equipment on all 1955 Cadillac models. This is the first major automotive product to be formed on the giant forging presses of the aluminum forging industry, originally installed to produce vital structural sections for modern aircraft. The precision of the heavy press forging operation minimizes machining and finishing operations, and at the same time permits improved tire wear because of its balanced, true-running characteristics. The new wheel was developed by Cadillac, Kelsey-Hayes Wheel Co., and Aluminum Company of America engineers.

The Ruud-Alcoa Alloy automatic water heater—the first gas-fired water heater to use an aluminum tank—was announced recently by the Ruud Manufacturing Co., Pittsburgh, Pa. The new tanks introduce no red rust into

the water and make the benefits of a solid aluminum tank available at a cost comparable to glass or enamel-lined tanks. The Ruud-Alcoa Alloy heater is another example of the increasing use of aluminum alloys for water systems. In the new Alcoa Building, for example, the domestic water system is equipped with aluminum pipe. These applications are helping to bring the advantages of corrosion-resistant aluminum to the average home.

•

### Plastic Valves and Fittings

THE FIRST all-molded polyvinylchloride (PVC) valves and fittings were introduced recently by the Lunkenheimer Co. of Cincinnati. The exclusive molding process (Stokes Molded Products, Trenton, N. J.) makes the material suitable for pressures up to 125 lb and temperatures up to 150 F, retains its natural corrosion resistance, and substantially reduces manufacturing costs. The trade name "Luncor" refers to its remarkable resistance to corrosive chemical action. Polyvinylchloride has been available in the form of corrosion-resistant piping for some time and has found many applications.

The valve is presently available in a Y-type globe design. A complete line of plastic fittings made of the same material includes caps, couplings, plugs, unions, reducing bushings, flanges, 45-deg and 90-deg elbows, and tees.

•

### Powdered Gears

THE FIRST successful application of the techniques of powder metallurgy to the production of high-strength machine parts requiring the properties of solid alloy steel has been jointly announced by Vanadium-Alloys Steel Co., Keystone Carbon Co., and Hydreco Division of New York Air Brake Co.

Vanadium-Alloys Steel Co. developed the alloy steel powder, a prealloyed type made by water disintegration of molten metal. Fabrication of the steel powder into gears with tensile strength exceeding 100,000 psi and greater resistance to wear than previously used (solid) gears was the work of Keystone Carbon Co. The third member of the team, Hydreco Division of New York Air Brake Co., carried out extensive tests of performance and durability, made the final application of the gear to its line of hydraulic pump equipment, and reports considerable savings in cost as well as superior characteristics for the powdered steel gears.

Keystone Carbon is presently producing the powdered alloy steel gears in $1\frac{1}{4}$-in. pitch diameter with lengths ranging from $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. The uniformity of one gear to another, the superior surface finish on the teeth, the resistance to wear, and the very high strength, not to mention the cost reduction, were all factors which led Hydreco to approve the gears for production. Any wear or scoring of the gear end faces is immediately reflected in loss of pump efficiency. Tests made under varying conditions of temperature, pressure, speed, pump running clearances, and oil cleanliness indicated superior resistance to end face wear and scoring. The surface finish on the faces of the powdered steel gear teeth is important in a hydraulic pump application as the volumetric efficiency is dependent on the seal offered by the mating of the teeth of the two pump gears.

•

### Toughy Steel at Lukens

THE FIRST heat of Lukens T-1 steel—125 tons of this extraordinarily tough and strong alloy—has been poured at the Lukens Steel Co. in Coatesville, Pa. Lukens is one of the world's leading steel plate producers, and is the first steel company in the world to be licensed by U. S. Steel to make the new alloy.

A great development of modern steel research, T-1 steel has a yield strength three times that of carbon steel, can be easily welded without preheating, has toughness at subzero temperatures, and resists wear and impact abuse. Industry spokesmen contend that the licensing of Lukens Steel will speed acceptance of the new steel in the trade, since many buyers insist on two sources of supply.

One of the orders from this first heat of Lukens T-1 was for 13 tons which will be rolled and formed into head segments for use in fabrication of air storage tanks in connection with a new high-speed tunnel being built at the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics, Langley Field, Va.

### New Magazine on Noise

*Noise Control* is the name of a new bi-monthly semitechnical publication to be launched by the Acoustical Society of America in November.

Information and subscriptions can be obtained by writing to *Noise Control*, 57 E. 55th St., New York 22, N. Y.

### Three-Day Magnetic Materials Conference Planned for Pittsburgh in June

THE Magnetics Subcommittee of the Basic Science Committee of the American Institute of Electrical Engineers, in cooperation with the American Physical Society and the American Institute of Mining and Metallurgical Engineers, has arranged a Conference and Exhibit on Magnetics at the William Penn Hotel, Pittsburgh, June 14–16, 1955.

The Conference plans to have six sessions devoted to the following subjects: Magnetic Materials, Metallurgy of Magnetic Materials, Mechanism of Magnetization, Application and Manufacturing of Soft Materials, Permanent Magnets, Measurements and Techniques, Ferritics, and High-Frequency Switching and Storage of Information.

The exhibit is under the direction of the Exhibit Committee of the Magnetics Subcommittee, John Osborn, chairman, and under the management of Richard Rimbach.

This Conference and Exhibit will bring together those interested in basic and applied work on magnetism and magnetic materials.

### U. S. Testing Co. Textile Course

THE United States Testing Co., Inc., announces the 18th Annual Summer Course in Textiles and Testing Techniques which will be conducted during the first half of the Teachers College Summer Session, Columbia University, July 5 to 22, 1955. The course will be held at the company's main laboratories in Hoboken, N. J. Teachers College accredits the course for 3 points credit toward a degree.

This comprehensive three-week course is open to representatives in the fields of home economics, education, retailing, and others who have had some elementary textile training. Through lectures, demonstrations, and practice sessions, students will cover all phases of analyses on textiles and related merchandise, identification of fibers, chemistry, detergency, and research. Special emphasis will be given to the various textile processing and finishing techniques. Field trips are scheduled during the course to supplement the class work.

For further information and application forms, write to United States Testing Co., Inc., 1415 Park Ave., Hoboken, N. J.

# Method for Determining the Squareness of Charpy V-Notch Test Specimen and Other Square or Parallel Bars

By S. E. Siemen[1]

One of the chief difficulties involved in the preparation of standard V-notch impact specimens is the determination of the squareness of the test bar. Precise methods that have been used in the past for determining this characteristic have been found to be far too time-consuming for use where large quantities of specimens are involved. Less precise methods that require less time do not yield sufficiently accurate results. In order to overcome these difficulties, the Watertown Arsenal Mechanical Services Office developed a technique and fixture which provides a fast and accurate method for checking squareness and parallelism. This technique, which is accurate to 0.0001 in., can also be adapted to checking pieces larger and smaller than the standard Charpy specimen by a simple modification of the fixture by means of interchangeable parts.

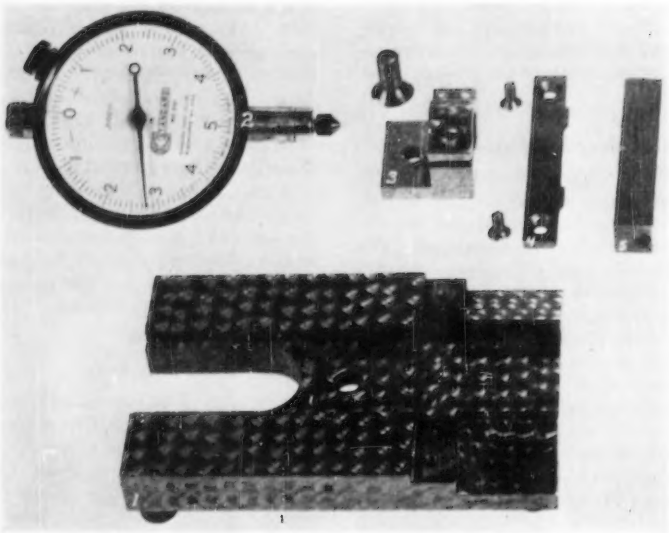


Fig. 1.—Squareness Fixture for Charpy Bar Inspection.

(1) Base
(2) Dial Indicator
(3) Indicator Clamp
(4) Knife Edge
(5) Charpy Specimen

## Procedure

The squareness fixture employs a dial indicator that will measure in 0.0001-in. increments. It is important to have the knife edge (Fig. 1) about 0.030 in. above the specimen supports, and to have a 0.015 in. radius on the knife edge. (Note undercut at the end of the specimen supports for clearance.) The indicator point must be modified to a sharp angle and the point rounded to about a 0.010 in. radius; this should be set to contact the Charpy bar about 0.030 in. below the top of the bar.

When using the squareness fixture, move the Charpy specimen to the knife edge. (Note the two contact points approximately $\frac{1}{4}$ in. long and 1 in. apart.) Set the dial indicator by using a Charpy bar, note reading, turn end for end, note reading, divide the difference by two and then, zero dial in. This will give a zero reading for the checking of future bars. Set the Charpy bars to be tested on the specimen supports, take a reading, turn 90 deg, and take another reading; repeat the operation until four sides have been measured. Check dial reading for out-of-squareness. Turn the bar end for end and take four readings as before; this gives a total of eight readings upon which to base determination of squareness.

The part of this bar measured between the indicator point and the knife edge is approximately 0.330 in.; consequently 0.0002 in. should be added to readings for a 0.394-in. Charpy bar. An accurate measurement of squareness of any two adjacent sides is obtainable by this method.

For measuring squareness of bars larger than Charpy impact test specimens, it is necessary to change the position of the indicator dial by the addition of spacer plates inserted under the indicator bracket.

[1] Chief, Mechanical Services Office, Watertown Arsenal, Watertown, Mass.

**To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership**

**To the ASTM Committee on Membership,**
**1916 Race St., Philadelphia, 3, Pa.**

**Gentlemen:**

**Please send information on membership to the company or individual indicated below:**

_____

_____

**This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.**

_____

**Signed**_____

**Date**_____ **Address**_____

# Crack Growth Testing: Variation Between Laboratories

By J. M. Buist and G. E. Williams

TECHNICAL Committee ISO/TC 45 of the International Organization for Standardization proposed a method for testing the rate of crack growth of vulcanized rubbers using the De Mattia test. In order to assess the suitability of the proposed ISO test as an international standard method, two cooperative experiments have been carried out involving a number of laboratories. Using prepared test specimens from one laboratory, considerable variations were found between the results obtained in different laboratories. It has been demonstrated that when the method of test is modified to reduce from $3\frac{1}{4}$ to 3 in. the free length of rubber between the clamps of the flexing machine, a more rapid test is obtained. Further, the test error and the laboratory-compound interaction are both slightly smaller. The interlaboratory variation is statistically significant with the $3\frac{1}{4}$-in. free length of rubber but lacks significance with the shorter free length. The results of the cooperative test have provided evidence which has been used in drafting an ISO test method in which a 3-in. free length of rubber is specified.

Numerous and varied tests have been proposed and used to measure the rate of crack growth of rubber compounds under dynamic flexing conditions. In spite of the importance of this characteristic with pneumatic tires, little coordination had been attempted until recent years, although the American Society for Testing Materials issued a tentative testing method (D 813) in 1944 with revisions in 1952.[1] The test

***A reduction in free length of test piece from $3\frac{1}{4}$ to 3 in. is recommended and has been adopted in a draft ISO test method.***

employs a De Mattia flexing machine with molded test specimens of standard dimensions, the crack being initiated by means of a suitable tool. It was proposed[2] and Technical Committee 45 of the International Organization for Standardization (ISO) accepted that the only test which could readily be adopted on an international scale should be based on the De Mattia machine, ASTM Method D 813 – 52 T and that given in British Standard 903-1950 being used as the basis of the proposed international test.

Some of the factors involved in carrying out the proposed ISO test have already been discussed.[3] Certain of the conclusions were arrived at as a result of a series of cooperative tests arranged by ISO/TC 45 to evaluate the suitability of the proposed ISO test as a standard method of crack growth testing. The purpose of this paper is to outline the conclusions arrived at as a result of the cooperative testing programs.

## Proposed ISO Crack-Growth Test

It is not necessary to give full details of the proposed ISO test but merely to note the more important features. The tests were all carried out on a machine of the De Mattia type operating under the conditions specified in ASTM tentative methods (D 430)[4] and in B.S. 903-1950, part 26. The test specimens also complied with the shape and dimensions quoted in the same specifications.

The cracks were initiated with a chisel-shaped tool suggested by the American delegation to ISO/TC 45. This tool is readily manufactured from an American No. 6 chisel point round awl and is used for puncturing specimens in the Ross Flexing Test. It is also described in the ASTM specification D 813 – 52 T. This tool makes an incision in the form of a slit 2 mm long cut completely through the thickness of the test specimen. The incision was made in the center of the molded groove in the specimen, with the length of the slit parallel to the long axis of the groove.

To insure that the cutting tool was inserted normal to the surface of the specimen and that each incision was made to the same depth in each, a special probe locator was employed.[5]

## Cooperative Tests

Two series of experiments have been completed with the assistance of a number of laboratories in several countries. In the first series results were obtained from seven laboratories and in the second series from nine laboratories. The purpose of the work was to determine the interlaboratory variation which occurred when several laboratories carried out an identical test as described in the ISO proposed test method. Each laboratory employed its own test machine of the

[5] British Patent No. 622,325.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Tentative Method of Test for Resistance of Vulcanized Rubber or Synthetic Elastomers to Crack Growth (D 813–44 T), 1944 Book of ASTM Standards, Part III, p. 1784; (D 813–52 T), 1952 Book of ASTM Standards, Part 6, p. 350.

[2] J. M. Buist and G. E. Williams, "A Review of the Mechanism of Flexcracking and Flexcracking Tests," *India Rubber World*, Vol. 124, pp. 309, 447, 567 (1951).

[3] J. M. Buist, "Flexcracking and Crack Growth Tests: Some Important Factors," *Transactions*, Inst. Rubber Industry, Vol. 29, p. 72 (1953).

[4] Tentative Methods of Dynamic Testing for Ply Separation and Cracking of Rubber Products (D 430–51 T), 1952 Book of ASTM Standards, Part 6, p. 158.

J. M. BUIST, Assistant Manager, Rubber Service Department, Imperial Chemical Industries Ltd., is chairman of several committees responsible for issuing British Standards and is convenor of the International Working Groups Studying Aging and Flexcracking.

G. E. WILLIAMS, since 1942 has been employed in the Rubber Service Department, Imperial Chemical Industries Ltd., Dyestuffs Division at Manchester, England, and in charge of their Physical Testing Laboratory for eight years.

TABLE I.—RESULTS FROM INTERLABORATORY CRACK-GROWTH TESTS (SERIES 1).

| Specimen | Laboratory 1 | Laboratory 2 | Laboratory 3 | Laboratory 4 | Laboratory 5 | Laboratory 6 | Laboratory 7 |
|---|---|---|---|---|---|---|---|
| **Kilocycles to 8 mm** | | | | | | | |
| Compound A—45-min Cure | | | | | | | |
| No. 1 | 1840.5 | 8.4 | 500.0 | 530.0 | 322.5 | 280.0 | 1000 |
| No. 2 | 1008.0 | 8.4 | 390.0 | 560.0 | ... | 288.8 | 2100 |
| No. 3 | 2803.5 | 8.12 | 370.0 | 375.0 | ... | 207.0 | 1100 |
| No. 4 | 1341.0 | 12.6 | 390.0 | 400.0 | 425.6 | 350.3 | 680 |
| No. 5 | 3033.0 | 9.5 | 300.0 | 425.0 | ... | 180.0 | 610 |
| No. 6 | 3034.2 | 8.12 | 320.0 | 300.0 | 543.8 | 164.0 | 3000 |
| Mean | 2176.7 | 9.2 | 378.3 | 431.7 | 430.6 | 244.9 | 1415 |
| Compound B—45-min Cure | | | | | | | |
| No. 1 | 1291.5 | 8.4 | 620.0 | 530.0 | 223.3 | 231.0 | 500 |
| No. 2 | 1008.0 | 8.4 | 105.0 | 75.0 | 137.2 | 67.5 | 900 |
| No. 3 | 718.5 | 8.12 | 370.0 | 800.0 | 375.5 | 267.0 | 610 |
| No. 4 | 1746.0 | 9.8 | 170.0 | 800.0 | 334.2 | 48.0 | 370 |
| No. 5 | 1320.0 | 9.8 | 280.0 | 400.0 | 325.1 | 28.5 | 210 |
| No. 6 | 1746.0 | 7.0 | 820.0 | 150.0 | 316.0 | 90.0 | 820 |
| Mean | 1305.0 | 8.6 | 394.2 | 459.2 | 285.2 | 122.0 | 568.3 |
| Compound C—30-min Cure | | | | | | | |
| No. 1 | 12.0 | 5.6 | 11.0 | 3.1 | 6.0 | 7.5 | 11.5 |
| No. 2 | 10.5 | 5.32 | 12.0 | 4.6 | 8.2 | 7.5 | 11.5 |
| No. 3 | 9.9 | 6.16 | 11.0 | 3.8 | 6.9 | 9.0 | 9.4 |
| No. 4 | 13.5 | 9.8 | 11.0 | 4.5 | 8.3 | 6.0 | 9.1 |
| No. 5 | 10.5 | 8.4 | 10.0 | 5.0 | 10.8 | 7.5 | 8.0 |
| No. 6 | 13.5 | 5.6 | 11.0 | 6.0 | 8.3 | 7.5 | 9.0 |
| Mean | 11.7 | 6.8 | 11.0 | 4.5 | 8.1 | 7.5 | 9.75 |
| Compound D—60-min Cure | | | | | | | |
| No. 1 | 7.5 | 3.64 | 6.5 | 3.3 | 6.0 | 6.0 | 8.2 |
| No. 2 | 7.5 | 4.48 | 8.0 | 3.6 | 6.0 | 6.0 | 9.2 |
| No. 3 | 9.0 | 4.20 | 9.0 | 3.3 | 4.4 | 4.5 | 8.8 |
| No. 4 | 9.0 | 6.44 | 6.0 | 3.5 | 5.8 | 6.0 | 8.0 |
| No. 5 | 9.0 | 5.60 | 7.0 | 3.6 | 5.8 | 4.5 | 6.6 |
| No. 6 | 9.0 | 5.04 | 6.0 | 3.5 | 7.0 | 4.5 | 6.0 |
| Mean | 8.5 | 4.9 | 7.1 | 3.5 | 5.8 | 5.3 | 7.8 |
| **Kilocycles to 15 mm** | | | | | | | |
| Compound A—45-min Cure | | | | | | | |
| No. 1 | >3799.5 | >44.8 | 930.0 | 2500.0 | ... | 1370.0 | 18 000–21 000 |
| No. 2 | >3799.5 | >46.4 | 960.0 | [a] | ... | 2510.0 | 15 000 |
| No. 3 | >3799.5 | >92.1 | 1580.0 | [a] | ... | 1370.0 | 18 000 |
| No. 4 | >6120.0 | >85.4 | 1400.0 | [a] | ... | 2952.0 | 10 000 |
| No. 5 | >6120.0 | >70.0 | 600.0 | 2000.0 | ... | 2952.0 | 6 000 |
| No. 6 | >6120.0 | >70.0 | 1090.0 | [a] | ... | 2952.0 | ... |
| Mean | >4959.8 | >67.1 | 1093.3 | >2250.0 | ... | 2351.0 | >13 400 |
| Compound B—45-min Cure | | | | | | | |
| No. 1 | 3799.5 | >18.2 | 1660.0 | 3500.0 | ... | 3360.0 | 6 000–8 000 |
| No. 2 | 3799.5 | >23.8 | 1220.0 | 1800.0 | ... | 550.0 | 10 000 |
| No. 3 | 3799.5 | >62.2 | 1380.0 | [a] | ... | 2840.0 | 8 000 |
| No. 4 | 6120.0 | >36.4 | 740.0 | [a] | ... | 530.0 | 4 000 |
| No. 5 | 6120.0 | >36.4 | 1060.0 | [a] | ... | 783.0 | 2 500 |
| No. 6 | 6120.0 | >15.4 | 4700.0 | [a] | ... | 2952.0 | 5 600 |
| Mean | 4959.8 | >32.1 | 1793.3 | >2650.0 | ... | 1835.8 | >6 016 |
| Compound C—30-min Cure | | | | | | | |
| No. 1 | 37.5 | 14.0 | 37.0 | 10.0 | 18.84 | 22.5 | 36.0 |
| No. 2 | 31.5 | 18.2 | 32.0 | 15.0 | 21.67 | 18.0 | 37.0 |
| No. 3 | 36.0 | 19.3 | 34.0 | 12.1 | 18.84 | 22.5 | 30.0 |
| No. 4 | 37.5 | 15.4 | 34.0 | 12.0 | 25.98 | 19.5 | 30.0 |
| No. 5 | 37.5 | 17.6 | 32.0 | 15.0 | 34.84 | 24.0 | 25.0 |
| No. 6 | 60.0 | 15.4 | 32.0 | 21.0 | 28.49 | 21.0 | 26.5 |
| Mean | 40.0 | 16.6 | 33.5 | 14.2 | 24.8 | 21.35 | 30.8 |
| Compound D—60-min Cure | | | | | | | |
| No. 1 | 25.5 | 8.4 | 19.0 | 10.9 | 16.33 | 12.5 | 24.5 |
| No. 2 | 31.5 | 10.4 | 25.0 | 10.8 | 16.33 | 19.5 | 25.0 |
| No. 3 | 28.5 | 9.2 | 29.0 | 11.8 | 13.51 | 12.0 | 25.0 |
| No. 4 | 25.5 | 9.8 | 21.0 | 8.6 | 18.48 | 16.5 | 23.5 |
| No. 5 | 21.0 | 11.2 | 18.0 | 8.3 | 15.97 | 12.0 | 22.5 |
| No. 6 | 21.9 | 11.2 | 19.0 | 8.8 | 24.72 | 13.5 | 20.5 |
| Mean | 25.7 | 10.0 | 23.5 | 9.9 | 17.6 | 14.3 | 23.5 |

[a] Cracks initiated at the edges of the test specimen had joined with the principal cracks.

De Mattia type under the normal conditions encountered in the individual laboratories. In order to eliminate a number of potential variables the compounding and molding of all test specimens were carried out in one laboratory. Each specimen was pierced with an ISO chisel tool supplied by the American delegation to ISO/TC 45; the specimens were randomized, divided into lots, and despatched to each laboratory. In an attempt to eliminate to some extent the effect of aging of the specimens before testing, each laboratory was asked to commence testing on a specified date.

Since the second series of tests was designed to determine the effect of a

change in the test method arising from an analysis of the results of the first series, it is proposed to deal with the results of the two series in the order in which they were obtained.

*First Series:*

Four compounds were used with recipes in parts by weight as follows:

| Compound | A | B | C | D |
|---|---|---|---|---|
| Natural rubber | 100 | 100 | ... | ... |
| GR-S | ... | ... | 100 | 100 |
| Stearic acid | 3 | 3 | ... | ... |
| Zinc oxide | 5 | 5 | 5 | 5 |
| MPC black | 47.5 | ... | ... | ... |
| HAF black | ... | 47.5 | 40 | 40 |
| Sulfur | 3.0 | 2.5 | 2.0 | 2.0 |
| Mercaptobenzothiazole | 0.85 | ... | ... | ... |
| *N*-cyclohexylbenzothiazyl sulfenamide | ... | 0.65 | 1.75 | 1.75 |
| Phenyl-β-naphthylamine | 1.0 | 1.0 | 1.0 | 1.0 |
| Cure at 141 C | 45 min | 45 min | 30 min | 60 min |

Six specimens from each compound were tested in each laboratory.

In an effort to equalize the conditions under which each compound was tested in any one laboratory the following scheme of testing was specified:

It was assumed that each test machine could accommodate a minimum of 6 test specimens and that many machines could take 12 specimens. If a machine had more than 6 spaces but less than 12 spaces, it was specified that only 6 of the spaces be chosen for the test, the same six spaces being used four times to complete the experiment.

In the case where the machine accommodated 6 specimens, the 6 positions were to be allocated the numbers 1 to 6, the 24 specimens being tested in four sets as follows:

| Position | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Set No. 1 | A[a] | B | C | D | A | B |
| Set No. 2 | C | D | A | B | C | D |
| Set No. 3 | B | C | D | A | B | C |
| Set No. 4 | D | A | B | C | D | A |

[a] The letters A to D refer to the four compounds.

If 12 positions were available, they were commonly arranged in two sets of 6 on each side of the machine. Calling the two sides of the machine X and Y and numbering the 6 positions on each side as above, the following scheme of testing was specified:

| Position | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Set No. 1 | | | | | | |
| Side X | A | B | C | D | A | B |
| Side Y | C | D | A | B | C | D |
| Set No. 2 | | | | | | |
| Side X | B | C | D | A | B | C |
| Side Y | D | A | B | C | D | A |

The test results obtained are given in Table I, from which it is evident that the variation between laboratories is extremely large. This was so obvious that no attempt was made to analyze the results, but the following conclusions were drawn from the figures:

1. All the laboratories were in general agreement regarding the relative order of merit of the four compounds tested.

2. Agreement between the laboratories is best (but not good) when the crack growth is fairly rapid. This is illustrated by the following figures, which compare the mean of six results obtained in each laboratory with compound C (30-min cure):

Kc to reach 8 mm
.....Range 4.5 to 11.7
Kc to reach 15 mm
.....Range 14.2 to 40.0

3. When the rate of crack growth is fairly slow, the divergence between the different laboratories is much broader. In fact, several laboratories failed to complete the test with compounds A and B in a reasonable time. It is apparent that the test is too slow for routine operation with compounds of this type. Furthermore, it was also noted that when the rate of crack growth was slow it was confused by the occurrence of subsidiary cracks spreading from the edges of the grooves and by radiation of the cracks in several directions from the ends of the principal crack, resulting in a decrease in strain and a considerable reduction in the rate of crack propagation.

In view of the above results it is worth while stating certain general requirements which seem desirable in a standard crack-growth test.

(*a*) It should be possible to complete the test with a "normal" rubber compound in a reasonable time. There is a general feeling that a too rapid test is also undesirable, since it may be the result of increasing the severity of the test to a quite unreasonable level.

(*b*) The rate of crack growth should be sufficiently great for the test to be completed before the appearance of subsidiary cracks which alter the stress distribution and confuse the appearance of the test specimen.

(*c*) The initial crack should be propagated as a unique crack.

One method of achieving requirement (*b*) is to terminate the test at an earlier stage. It has already been shown that requirement (*c*) is determined to a large extent by the design of the cutting tool.[5]

Further consideration should, however, be given to the results of the cooperative experiment. The test specimens were so randomized that it can be assumed that variation between the sets of six specimens from a single compound was negligible. This has not been proved, but it will be noted that the variation between laboratories is appreciably greater than the variation between replicate test specimens tested in each laboratory. It can be assumed, therefore, that the differences between laboratories were the result of different test conditions. Ambient conditions were noted and, although variable, were not sufficiently different to account for the differences obtained. It is, of course, possible that some feature of the ambient conditions was sufficiently critical to influence the result and that its importance is not yet realized. A considerable variation of ozone concentration between laboratories could have such an effect, but no information is available on this point. In all cases the rate of flexing was sufficiently close to the specified 300 cpm.

The remaining test variables are (1) the mean strain and (2) the dynamic strain, which are determined by (*a*) the relative setting of the fixed and moving clamps, (*b*) the amplitude of movement of the moving clamp, and (*c*) the free length of rubber between the clamps. The effects of these factors have already been discussed in some detail,[3] and it is sufficient to reiterate that there is evidence that variations in both the mean strain and the dynamic strain result in marked variations in rate of crack growth. In particular the free length of rubber between the clamps is of great importance. Table II shows the effect of free length on the number of cycles for a crack to grow from 2 to 8 mm with a natural rubber compound containing a channel black but no antioxidant. These results were obtained with the De Mattia machine adjusted in the standard manner with the distance between the clamps oscillating between ¾ and 3 in.

The important conclusion shown by these results is the fact that a variation in free length from 3 to 3⅛ in. has a much smaller effect than a variation from 3⅛ to 3¼ in. Advantage would therefore be anticipated if the free length of rubber were reduced from the "standard" length of 3¼ in. (ASTM D 430 and B.S. 903-1950, part 26).

TABLE II.—EFFECT OF FREE LENGTH OF TEST SPECIMEN.

| Free Length of Test Specimen, in. | 3 | 3⅛ | 3¼ |
|---|---|---|---|
| No. of kilocycles to grow to 8 mm | 5.65 | 8.85 | 24.75 |
| Minimum strain, per cent | 0 | 39 | 57 |
| Maximum strain, per cent | 136 | 164 | 153 |
| Strain range, per cent | 136 | 126 | 97 |

[5] J. M. Buist and E. F. Powell, "Improvements in Cut-Growth Testing," *Transactions*, Inst. Rubber Industry, Vol. 27, p. 49 (1951).

The second series of tests was organized to determine whether, in fact, a free length of 3 in. would have advantages over a free length of $3\frac{1}{4}$ in. as initially proposed in the ISO test.

*Second Series:*

Since the first series of tests gave most difficulty in the testing of compounds A and B and since an additional variable, the free length of rubber, was to be investigated, these two compounds only were used in the second series.

The basic test method was exactly as in the first series, but in each laboratory six specimens from each compound were tested with a free length of rubber of 3 in. and another six with a free length of $3\frac{1}{4}$ in. With the 3-in. free length the test was terminated with a crack length of 15 mm, but the test was terminated with a crack length of 8 mm when the free length was $3\frac{1}{4}$ in.

The specimens were tested as follows in each laboratory:

Using a machine to accommodate 6 specimens:

| Position | 1 | 2 | 3 | 4 | 5 | 6 | Free Length, in. |
|---|---|---|---|---|---|---|---|
| Set No. 1 | A | B | A | B | A | B | 3 |
| Set No. 2 | B | A | B | A | B | A | 3 |
| Set No. 3 | A | B | A | B | A | B | $3\frac{1}{4}$ |
| Set No. 4 | B | A | B | A | B | A | $3\frac{1}{4}$ |

Using a machine to accommodate 12 specimens:

| Position | 1 | 2 | 3 | 4 | 5 | 6 | Free Length, in. |
|---|---|---|---|---|---|---|---|
| Set No. 1 | | | | | | | |
| Side X | A | B | A | B | A | B | 3 |
| Side Y | B | A | B | A | B | A | 3 |
| Set No. 2 | | | | | | | |
| Side X | A | B | A | B | A | B | $3\frac{1}{4}$ |
| Side Y | B | A | B | A | B | A | $3\frac{1}{4}$ |

There was little point in mixing the test specimens with the different free lengths of rubber, since the time to complete the test was considerably longer with the $3\frac{1}{4}$-in. free length, and testing time would have been wasted without any benefits.

The results obtained in the different laboratories are given in Table III. A statistical analysis of the results is given in Table IV.

In a few isolated cases the test on a particular test specimen was not completed. For the purpose of the analysis the actual number of kilocycles quoted in Table III was used.

It is evident from Table IV that the residual errors vary considerably in magnitude and that the results as a whole are not normally distributed. Very approximately the residual error is roughly proportional to the mean

TABLE III.—INTERLABORATORY CRACK-GROWTH TESTS—INVESTIGATION OF FREE LENGTH.

3-IN. FREE LENGTH

| | Kilocycles from 2 to 4 mm | | | | | | | Kilocycles from 4 to 8 mm | | | | | | | Kilocycles from 8 to 15 mm | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Specimen No. | 1 | 2 | 3 | 4 | 5 | 6 | Total | 1 | 2 | 3 | 4 | 5 | 6 | Total | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| **Compound A** | | | | | | | | | | | | | | | | | | | | | |
| Laboratory 1 | 1.8 | 2.4 | 1.2 | 3.0 | 1.8 | 1.8 | 12.0 | 46.8 | 81.6 | 21.0 | 57.0 | 70.2 | 46.2 | 322.8 | 112.5 | 136.5 | 97.8 | 142.5 | 136.5 | 118.5 | 744.3 |
| Laboratory 2 | 12.0 | 14.0 | 3.0 | 12.5 | 8.0 | 12.0 | 61.5 | 88.0 | 66.0 | 87.0 | 116.0 | 73.8 | 85.5 | 516.3 | 140.0 | 110.0 | 170.0 | 185.0 | 158.0 | 205.0 | 968.0 |
| Laboratory 3 | 7.0 | 4.0 | 4.0 | 6.0 | 6.0 | 6.0 | 33.0 | 45.0 | 44.0 | 48.0 | 46.0 | 59.0 | 22.0 | 264.0 | 189.0 | 50.0 | 193.0 | 178.0 | 173.0 | 170.0 | 953.0 |
| Laboratory 4 | 7.4 | 1.5 | 1.5 | 4.4 | 4.4 | 2.4 | 21.6 | 115.0 | 52.0 | 90.0 | 93.0 | 90.0 | 48.0 | 488.0 | 340.0 | 190.0 | 250.0 | 140.0 | 150.0 | 200.0 | 1270.0 |
| Laboratory 5 | 1.5 | 2.0 | 2.0 | 1.7 | 1.3 | 1.3 | 9.8 | 5.5 | 58.0 | 58.0 | 58.3 | 5.7 | 38.7 | 224.2 | 168.0 | 240.0 | 152.5 | 240.0 | 168.0 | 235.0 | 1203.5 |
| Laboratory 6 | 1.9 | 4.5 | 2.1 | 1.5 | 1.6 | 8.0 | 19.6 | 27.1 | 65.0 | 5.1 | 37.5 | 35.4 | 63.5 | 233.6 | 161.0 | 126.0 | 112.8 | 156.0 | 161.0 | 123.5 | 840.3 |
| Laboratory 7 | 1.2 | 4.2 | 1.8 | 6.6 | 2.4 | 2.4 | 18.6 | 42.4 | 95.0 | 41.7 | 56.4 | 87.6 | 60.6 | 383.7 | 172.5 | 189.0 | 136.5 | 216.0 | 234.0 | 252.0 | 1200.0 |
| Laboratory 8 | 5.0 | 2.5 | 3.5 | 2.5 | 2.5 | 2.5 | 18.5 | 55.0 | 37.5 | 56.0 | 37.5 | 46.5 | 47.5 | 280.0 | 121.0 | 140.0 | 176.5 | 160.0 | 132.0 | 151.0 | 880.5 |
| Laboratory 9 | 4.0 | 11.0 | 15.0 | 7.0 | 8.0 | 2.0 | 47.0 | 47.5 | 69.0 | 91.0 | 52.0 | 63.0 | 40.0 | 362.5 | 141.0 | 108.0 | 105.0 | 108.0 | 117.0 | 148.0 | 727.0 |
| **Compound B** | | | | | | | | | | | | | | | | | | | | | |
| Laboratory 1 | 1.8 | 1.5 | 1.8 | 1.2 | 1.8 | 1.8 | 9.9 | 6.6 | 3.9 | 7.2 | 9.0 | 5.4 | 3.6 | 35.7 | 63.6 | 42.6 | 75.0 | 79.8 | 82.8 | 9.0 | 352.8 |
| Laboratory 2 | 1.7 | 1.5 | 2.0 | 2.2 | 2.3 | 1.7 | 11.4 | 4.9 | 4.9 | 9.0 | 7.8 | 11.2 | 5.5 | 43.3 | 18.4 | 22.6 | 124.0 | 70.0 | 106.5 | 58.6 | 400.1 |
| Laboratory 3 | 3.0 | 3.0 | 3.0 | 3.0 | 3.5 | 3.0 | 18.5 | 5.0 | 5.0 | 5.0 | 5.0 | 4.5 | 5.0 | 29.5 | 62.0 | 96.0 | 32.0 | 76.0 | 32.0 | 72.0 | 370.0 |
| Laboratory 4 | 1.5 | 1.3 | 1.5 | 1.5 | 1.5 | 1.5 | 8.8 | 4.9 | 6.0 | 5.9 | 5.3 | 5.9 | 9.4 | 37.4 | 110.0 | 105.0 | 66.0 | 120.0 | 125.0 | 135.0 | 661.0 |
| Laboratory 5 | 1.6 | 1.3 | 2.0 | 1.5 | 1.4 | 1.4 | 9.2 | 3.8 | 5.1 | 6.0 | 4.6 | 4.2 | 4.6 | 28.3 | 29.6 | 69.6 | 52.9 | 28.9 | 44.4 | 79.0 | 303.5 |
| Laboratory 6 | 1.7 | 1.8 | 1.7 | 2.1 | 2.1 | 1.3 | 10.7 | 5.3 | 4.6 | 4.4 | 4.5 | 4.4 | 5.9 | 29.1 | 98.0 | 28.6 | 37.9 | 48.4 | 39.6 | 97.8 | 350.3 |
| Laboratory 7 | 1.2 | 1.8 | 1.8 | 1.8 | 1.8 | 1.2 | 9.6 | 6.3 | 3.6 | 16.2 | 3.6 | 6.3 | 3.0 | 39.0 | 109.5 | 14.0 | 144.0 | 9.6 | 154.5 | 9.3 | 440.9 |
| Laboratory 8 | 1.5 | 1.5 | 1.5 | 2.0 | 1.5 | 1.5 | 9.5 | 4.0 | 5.0 | 5.0 | 5.0 | 4.0 | 5.5 | 28.5 | 24.5 | 33.5 | 66.5 | 61.5 | 72.5 | 42.0 | 300.5 |
| Laboratory 9 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 12.0 | 5.0 | 10.5 | 7.0 | 8.0 | 5.0 | 5.0 | 40.5 | 56.0 | 94.5 | 59.0 | 112.0 | 72.5 | 47.0 | 441.0 |

3¼-IN. FREE LENGTH

| | Kilocycles from 2 to 4 mm | | | | | | | Kilocycles from 4 to 8 mm. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Specimen No. | 1 | 2 | 3 | 4 | 5 | 6 | Total | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| **Compound A** | | | | | | | | | | | | | | |
| Laboratory 1 | 735.0 | 117.0 | 321.0 | 924.0 | 717.0 | 78.0 | 2892.0 | >4221.0 | 2103.0 | 3204.0 | 3510.0 | 3456.0 | 1629.0 | >18 123.0 |
| Laboratory 2 | 350.0 | 400.0 | 271.0 | 425.0 | 275.0 | 193.0 | 1914.0 | 1275.0 | 1191.0 | 794.0 | 1164.0 | 734.0 | 854.0 | 6 012.0 |
| Laboratory 3 | 385.0 | 887.0 | 783.0 | 365.0 | 2122.0 | 449.0 | 4991.0 | >3415.0 | >2913.0 | >3017.0 | 3231.0 | >1678.0 | 3351.0 | >17 605.0 |
| Laboratory 4 | 81.0 | 40.0 | 195.0 | 83.0 | 170.0 | 620.0 | 1189.0 | 510.0 | 830.0 | 640.0 | 1250.0 | 2100.0 | 2500.0 | 7 830.0 |
| Laboratory 5 | 5.0 | 7.5 | 15.0 | 10.0 | 10.0 | 10.0 | 57.5 | 220.0 | 192.5 | 210.0 | 140.0 | 140.0 | 140.0 | 1 042.5 |
| Laboratory 6 | 140.0 | 215.0 | 64.0 | 180.0 | 335.0 | 120.0 | 1054.0 | 1210.0 | 925.0 | 386.0 | 1250.0 | 1365.0 | 1160.0 | 6 296.0 |
| Laboratory 7 | 99.0 | 288.0 | 63.0 | 630.0 | 708.0 | 666.0 | 2454.0 | 1053.0 | 864.0 | 1083.0 | 2540.0 | 2874.0 | 2916.0 | 11 330.0 |
| Laboratory 8 | 160.0 | 250.0 | 143.0 | 100.0 | 62.0 | 100.0 | 815.0 | 857.0 | 964.0 | 964.0 | 885.0 | 638.0 | 460.0 | 4 768.0 |
| Laboratory 9 | 200.0 | 210.0 | 150.0 | 195.0 | 180.0 | 710.0 | 1645.0 | 1800.0 | 2600.0 | 1870.0 | 1645.0 | 1420.0 | 3200.0 | 12 535.0 |
| **Compound B** | | | | | | | | | | | | | | |
| Laboratory 1 | 90.0 | 99.0 | 90.0 | 63.0 | 54.0 | 90.0 | 486.0 | 942.0 | 1194.0 | 627.0 | 348.0 | 663.0 | 834.0 | 4 608.0 |
| Laboratory 2 | 17.5 | 21.4 | 26.0 | 80.0 | 56.0 | 49.7 | 250.6 | 263.0 | 197.0 | 307.0 | 633.0 | 430.0 | 431.0 | 2 261.0 |
| Laboratory 3 | 42.0 | 16.0 | 24.0 | 42.0 | 50.0 | 50.0 | 224.0 | 1231.0 | 399.0 | 425.0 | 660.0 | 1584.0 | 2253.0 | 6 552.0 |
| Laboratory 4 | 6.5 | 28.0 | 53.0 | 59.0 | 50.0 | 59.0 | 255.5 | 130.0 | 345.0 | 480.0 | 125.0 | 540.0 | 770.0 | 2 390.0 |
| Laboratory 5 | 3.0 | 3.0 | 3.0 | 2.6 | 3.0 | 3.0 | 17.6 | 9.5 | 12.0 | 12.0 | 9.9 | 8.0 | 59.5 | 110.9 |
| Laboratory 6 | 5.0 | 34.0 | 4.6 | 3.2 | 22.0 | 9.0 | 77.8 | 445.0 | 676.0 | 92.4 | 249.8 | 378.0 | 531.0 | 2 372.2 |
| Laboratory 7 | 18.0 | 4.2 | 22.5 | 108.0 | 18.0 | 31.5 | 202.2 | 306.0 | 212.0 | 320.0 | 1638.0 | 369.0 | 1120.0 | 3 965.0 |
| Laboratory 8 | 13.0 | 10.0 | 10.0 | 6.0 | 8.0 | 6.0 | 53.0 | 125.0 | 390.0 | 240.0 | 96.0 | 208.0 | 230.0 | 1 289.0 |
| Laboratory 9 | 65.0 | 32.0 | 34.0 | 41.0 | 58.0 | 58.0 | 288.0 | 835.0 | 368.0 | 250.0 | 249.0 | 1060.0 | 370.0 | 3 332.0 |

that is, the coefficient of variation is approximately a constant, lying between 0.3 and 0.6. In view of this the logarithms (base 10) of the individual results were calculated and a similar analysis performed. It can be estimated that the residual variance for a free length of 3 in. should then be of the order of 0.02 to 0.05. The statistical analysis of the logarithms is given in Table V.

The factors given in Table V are split into their component parts in Table VI.

From Tables V and VI it is concluded:

1. The test error is similar whether a 3- or 3¼-in. free length be used, although there is a tendency for it to be slightly smaller with a 3-in. free length, particularly in the 2- to 4-mm stage of testing.

2. If equivalent stages of cracking are compared, the interaction is slightly smaller with the 3-in. free length of rubber and is significantly large at the 2- to 4-mm stage of growth in both cases.

3. Both methods of test readily discriminated between the two compounds.

4. There was a highly significant variation between laboratories when a 3¼-in. free length of rubber was used, but this effect was not evident when the 3-in. free length was adopted. Table VI confirms that the variation between laboratories ($\sigma_L^2$) is much smaller for the 3-in. free length of rubber.

## General Conclusions

The two series of tests have shown that there are large variations between the test results obtained in several laboratories when carrying out a specified crack-growth test. The reasons for these variations have not been determined and it is evident that detailed studies of the test would be necessary in order to reduce the interlaboratory variations.

Table VII gives the mean result with each compound in each laboratory, the results being those obtained in the second series of tests.

In all cases compound A is rated as superior to compound B, but the relative rating varies from laboratory to laboratory. The two compounds were sufficiently different to allow easy discrimination when either a 3- or 3¼-in. free length of rubber was used. It is not possible to say whether changing the free length of rubber alters the discriminating power of the test.

The 3-in. free length has the advantage of giving a faster test which is suitable even for rubber compounds with excellent resistance to crack growth. Interlaboratory variation is considerably reduced and, in the experiment described, is not statistically significant. The validity of the suggestions made[3] for improving the reproducibility of crack-growth tests is therefore confirmed.

The logarithms of the number of kilocycles to produce a given degree of crack growth are subject to a test error which is of the same order of magnitude irrespective of the stage of cracking. The mean test error of the logarithms is 0.23. It should be noted, however, that a graph of the logarithms of the number of kilocycles against the length of crack is seldom linear.

TABLE IV.—ANALYSIS OF TEST RESULTS.

| | D. of F.[a] | Mean Squares | | | | |
|---|---|---|---|---|---|---|
| Free Length | | 3 in. | | | 3¼ in. | |
| Stage of Growth | | 2 to 4 mm | 4 to 8 mm | 8 to 15 mm | 2 to 4 mm | 4 to 8 mm |
| Source of Variance: | | | | | | |
| Between laboratories (L) | 8 | 28.90 | 1 028.1 | 6 162.7 | 194 406 | 5 164 200 |
| Between compounds (E) | 1 | 186.70 | 70 728.0 | 24 7154.0 | 2 127 120 | 34 200 000 |
| L × E interaction | 8 | 22 03 | 848.0 | 2 762.8 | 157 014 | 1 097 830 |
| Residual | 90 | 3.22 | 203.9 | 1 434.8 | 43 197 | 271 799 |
| Mean | | 3.16 | 31.36 | 114.88 | 174.69 | 1 040.94 |

[a] Degrees of freedom.

TABLE V.—ANALYSIS OF TEST RESULTS.
(Basis logs)

| | D. of F. | Mean Squares | | | | |
|---|---|---|---|---|---|---|
| Free Length | | 3 in. | | | 3¼ in. | |
| Stage of Growth | | 2 to 4 mm | 4 to 8 mm | 8 to 15 mm | 2 to 4 mm | 4 to 8 mm |
| Source of Variance: | | | | | | |
| Between laboratories (L) | 8 | 0.3055 | 0.1580 | 0.0958 | 2.6025[a] | 2.4499[b] |
| Between compounds (E) | 1 | 2.1393[a] | 25.5806[b] | 6.4765[b] | 22.1487[b] | 9.7100[b] |
| L × E interaction | 8 | 0.1298[b] | 0.0698 | 0.0428 | 0.2870[a] | 0.1155 |
| Residual | 90 | 0.0268 | 0.0387 | 0.0482 | 0.0859 | 0.0552 |
| Mean | | 0.3921 | 1.2052 | 1.9576 | 1.7724 | 2.7635 |

[a] Significant at 0.01 level.
[b] Significant at 0.001 level.

TABLE VI.—COMPONENTS OF VARIANCE.

| Free Length | 3 in. | | | 3¼ in. | |
|---|---|---|---|---|---|
| Stage of Growth | 2 to 4 mm | 4 to 8 mm | 8 to 15 mm | 2 to 4 mm | 4 to 8 mm |
| Source of Variance: | | | | | |
| Laboratories $\sigma_L^2$ | 0.0147 | 0.0074 | 0.0044 | 0.1929 | 0.1946 |
| L × E interaction $\sigma_{LE}^2$ | 0.0172 | 0.0052 | 0 | 0.0335 | 0.0101 |
| Residual $\sigma_e^2$ | 0.0268 | 0.0387 | 0.0482 | 0.0859 | 0.0552 |

TABLE VII.—MEAN RESULTS, SECOND SERIES.

| Free Length | 3 in. | | | | | | 3¼ in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Stage of Growth | 2 to 4 mm | | 4 to 8 mm | | 8 to 15 mm | | 2 to 4 mm | | 4 to 8 mm | |
| Compound | A | B | A | B | A | B | A | B | A | B |
| Laboratory 1 | 2.0 | 1.7 | 53.8 | 5.9 | 124.1 | 58.8 | 482.0 | 81.0 | >3020.5 | 768.0 |
| Laboratory 2 | 10.3 | 1.9 | 86.1 | 7.2 | 161.3 | 66.7 | 319.0 | 41.8 | 1002.0 | 377.6 |
| Laboratory 3 | 5.5 | 3.1 | 44.0 | 4.9 | 158.9 | 61.7 | 833.5 | 37.3 | >2934.1 | 1092.0 |
| Laboratory 4 | 3.6 | 1.5 | 81.3 | 6.2 | 211.7 | 110.1 | 198.2 | 42.6 | 1305.0 | 398.3 |
| Laboratory 5 | 1.6 | 1.5 | 37.4 | 4.7 | 200.6 | 50.6 | 9.6 | 2.9 | 173.8 | 18.5 |
| Laboratory 6 | 3.3 | 1.8 | 38.9 | 4.9 | 140.1 | 58.4 | 175.7 | 12.9 | 1049.3 | 395.4 |
| Laboratory 7 | 3.1 | 1.6 | 63.9 | 6.5 | 200.0 | 73.5 | 409.0 | 33.7 | 1888.3 | 660.8 |
| Laboratory 8 | 3.1 | 1.6 | 46.7 | 4.8 | 146.8 | 50.1 | 135.8 | 8.8 | 794.7 | 214.8 |
| Laboratory 9 | 7.8 | 2.0 | 60.4 | 6.8 | 121.2 | 73.5 | 274.1 | 48.0 | 2089.1 | 555.3 |

*Acknowledgment:*

The authors wish to acknowledge the cooperation of the following laboratories and organizations in the experimental work: Pirelli, Italy; "Semperit" Rubber Works, Austria; Dätwyler A.G., Switzerland; Sharples Chemicals Inc., U.S.A.; Laboratoire de Recherches et de Controle du Caoutchouc, France; R. W. Greeff and Co. Ltd., Great Britain; London Advisory Committee for Rubber Research, Great Britain; Research Association of British Rubber Manufacturers, Great Britain; Dunlop Rubber Co. Ltd. (G.R.G. Division), Great Britain.

# Some Observations on the Mechanics of Alkali-Aggregate Reaction*

By L. S. Brown

*The author describes visual features of alkali-aggregate reaction in concrete whereby reaction may be identified not only as having occurred but particularly as having been a cause of physical damage.*

COMMON procedure in the examination of a distressed concrete structure is to study the pattern of dislocation or failure in an effort to locate and identify the causative stresses. Potential causes of distress are numerous, and it is necessary to utilize the displacement pattern to determine which particular one may be implicated.

Occasionally the pattern of distress observed in the field examination has indicated a gross expansion of the concrete. While this indicates even further the existence of some abnormal secondary mineralogic or chemical change within the concrete, the field examination often fails to reveal the nature of the constitutional change. Resort then is had to the microscope.

The approach of the microscopist basically is the same as that of the field engineer. Several agents or processes are known as potential causes of gross expansion. Microscopical examination may reveal any one or more of these secondary changes. But proof that any one has been involved in the gross expansion requires the finding of displacement distinctively associated with it.

Samples from a number of structures showing gross expansion have come to the author for examination. Since Stanton's exposition of alkali-aggregate reaction (**1**,**2**,**3**)[1] as a possible cause of expansion, there has been in each case a particular interest in learning whether alkali-aggregate reaction was involved. Presumably this would be recognized by occurrence of the viscous, varnish-like gels and aggregate alteration borders noted by Stanton as indicative of the reaction. Obviously it would be necessary also to find displacement associated with these, or other, secondary features. That does not mean that alkali-aggregate reaction was the only damaging agent sought or found. In general, others also are present. It does mean that, in so far as alkali-aggregate reaction can be proven to have been a cause of damage, both secondary alteration and associated displacement had to be found.

Features of this combined evidence as observed in a variety of concretes will be presented in this paper, mostly by photograph. In this presentation only construction date and geographical locality will be given, since there is no point in identifying or describing the different structures. All were of concrete and in all cases the field examination had indicated a gross expansion.

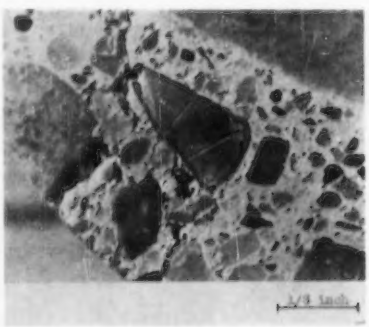



Fig. 1

### Procedure

For visual study, it is necessary to get at the interior of the concrete. This can be accomplished either by cutting up the specimen—with a diamond saw, for example—or by breaking it up by hammer. The plane-cut or broken surfaces thus newly exposed are studied as they are made available.

Breaking up the specimen by hammer offers the advantage of quick and easy application, especially in the field. Of the two disadvantages, one is that the concrete usually is already more or less extensively cracked, and breaks induced by hammer tend to follow pre-existing fractures. The broken surfaces, though newly exposed, actually are frequently old, and commonly they are obscured by infiltrating dirt and other secondary accumulations. The other disadvantage is that pre-existing displacement, usually manifested by fractures, is one of the objectives of the search, and when a hammer has been used one cannot always be certain of the origin of minute fractures.

The advantage of plane-cut surfaces is that pre-existing structural relations are preserved. The disadvantage is the difficulty of wide application.

The practice of the author has been to cut through the specimen first and to break up one of the portions. Virtually the same features may be observed on either surface, though differing considerably in manifestation. Full interpretation requires both types of observation. This procedure has the further advantage that at least one portion can be kept for record.

Since fractures and units of aggregate run into megascopic dimensions, significant observations often can be made by the unaided eye, and usually only low magnification by binocular microscope is required. Most of the photographs in the present paper were taken at low magnification. Both plane-cut and broken surfaces are illustrated. When mineral identifications were required, bits of material were picked out by needle point and examined petrographically as powder mounts. Occasionally a polished section was prepared for micrographic examination at high magnification.

### Plane-Cut Surfaces

*Features.*—Figure 1, taken from a 1922 construction in Idaho, shows aggregate of a natural sand and gravel. The piece of aggregate near the center of the field obviously is a center of disruption, for cracks through the enclosing mortar extend away from it in all directions. Several other features are to be noted:

**L. S. BROWN, Senior Research Petrographer, Portland Cement Assn., has since 1943 been working on deterioration and disintegration in concrete in structures.**

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* This paper was presented at the Fifty-seventh Annual Meeting of the Society, June 13-18, 1955, in Chicago, Ill.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

1. There is a uniform dark band in the peripheral zone.
2. The pebble is extensively fractured internally.
3. Transverse fractures through the gray interior terminate abruptly at the inner edge of the dark border or narrow appreciably in passing through it.
4. Along much of the periphery, the dark border zone is cracked or spalled away from the gray interior.
5. The cracks are all open, clean, and empty, except where passing through the peripheral dark zone.

Figures 2 and 3 represent a 1920 construction in Virginia. Fine aggregate is a natural sand. Coarse aggregate is a crushed ledge rock. Note the darkened borders, interior cracks, and occasional radiating external cracks.

Figure 4 shows a portion of a piece of aggregate several times larger than the field of view. This is from a 1933 construction in Arizona. The peripheral dark band is considerably narrower than in the preceding occurrences. Note peripheral spalling which, under the microscope, could be followed around the full perimeter.

Figure 5 is from a 1920 construction in New York. Aggregate is a natural sand and gravel. A particular feature here is that the aggregate is practically wholly quartz. The narrow dark borders can be seen, though less plainly because of the better optical continuity of quartz. Observable displacement is limited to a single crack that passes from one piece of aggregate into another, terminating in both.

The concrete illustrated in Fig. 6 is from a 1920 construction in Arizona. The piece of gravel shows a peripheral spalling around the full perimeter, just inside the narrow dark border. One or two fine cracks can be seen radiating externally.

Figures 7 and 8 show a portion of a section through a mortar bar 1 by 1 by 11¼ in. The aggregate is all pyrex glass, crushed and graded. Storage was at room temperature over water, in a covered container. The bar showed 0.6 per cent expansion in 3 months. Center detail is a cross-section of a glass fragment that happened to have been cylindrical. The central portion is dark because of the optical continuity of glass. The border is light because of extensive peripheral fracturing. The cracking is seen to better advantage in Fig. 8. Here the specimen has been tilted slightly to achieve direct reflection of the light.

Figure 9 shows a portion of a vertical section through a glass insert in an old sidewalk skylight panel in Chicago. The panel unit was bowed up like a pillow, evidencing considerable expansion,

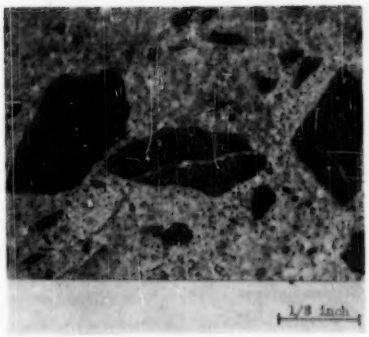



Fig. 2

Fig. 3

Fig. 4

Fig. 5

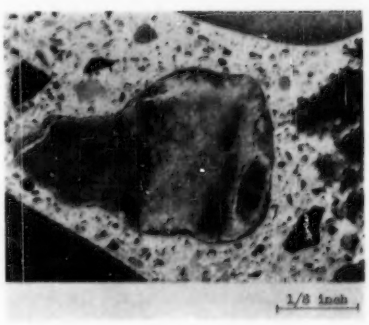



Fig. 6

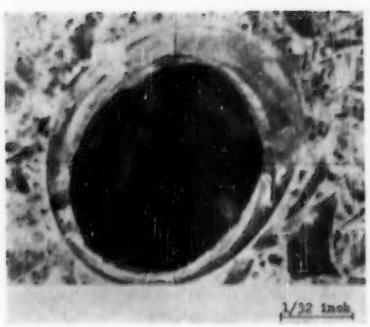



Fig. 7

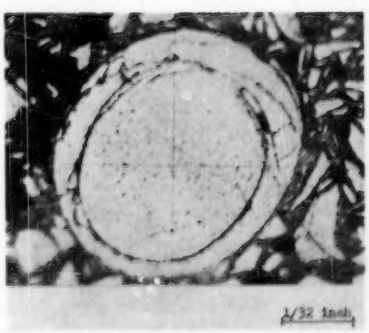



Fig. 8

Fig. 9

and the glass inserts were badly cracked. Note the extensive spalling of the glass parallel to the boundary and the internal transverse fractures that start mostly in the spalled border zone.

*Discussion.*—The search has been for evidence of secondary change in the aggregate associated with secondary dislocation or displacement. Secondary is a convenient way of designating developments occurring relatively long after the primary reactions of setting and hardening of the concrete. In all of the foregoing illustrations the same features have been seen, differing only in degree of development, the only manifest departure being that constitutional alteration of the glass could not be perceived. It may be appropriate at this point to discuss the evidence designating the observed features to be of secondary origin.

Fracturing through the mortar obviously is a secondary feature. Turning again to Fig. 1, it is almost equally obvious that the fracturing within the piece of aggregate is secondary, for a particle so fractured could hardly be expected to remain intact through the mixing operation. It also is obvious that the outer zone of the particle differs from the inner portion. Whatever the difference may be, there are two observations that indicate the darkened zone to be of secondary generation. One of these is the observed relation between the darkened zone and the internal fracturing. The other is the wholly similar darkened zone on the freshly crushed stone shown in Figs. 2 and 3, which obviously could not have been present prior to placement in the concrete.

It also is appropriate at this point to consider what disposition of forces could have caused the internal and external fracturing observed in these illustrations. The indication of the pattern is that the substance of the darkened zone has increased in volume. This necessarily exerts a radial compression, and hence tangential tension, in the enclosing mortar, which evidently is the cause of the radial cracks sometimes seen in the mortar. But bulk enlargement of the shell also tends to put the interior in tension, just as a locomotive wheel tire, on heating, increases in inside diameter. This apparently is the cause of the internal transverse cracks and peripheral spalling observed inside the aggregate particle, although this tension may not become effective until after relief of the compressive stresses on the outside.

These considerations indicate that the manner in which aggregate alteration contributes to the gross structural expansion is effectively by direct enlargement of the aggregate units. It might be well to point out that the conclusion thus drawn is independent of the nature or constitution of the cement, or the aggregate, or the concrete, or the alteration processes. The question has been one simply of proving a physical relation between aggregate alteration and gross structural expansion. For this reason no particular effort has been given to description of either the aggregates or the reaction processes.

### Broken Surfaces

*Features.*—Mention already has been made of the secondary accumulations often present on the surfaces of old fractures opened up by hammer. Consider, for example, Fig. 10, from the same concrete shown in Figs. 2 and 3. The broken surface of the mortar portion is covered by a film of white gel which has shrunk and cracked on drying out after exposure. Portions of two pieces of aggregate also are seen, the broken surface passing through them. The dark borders are easily perceivable. Inside the dark borders there is a white deposit that thins out and ceases inwardly, exposing the central portion of unaltered rock.

Figures 11 and 12 show alteration of several different kinds of rock in the concrete previously illustrated in Fig. 4. The fractures again pass through the altered pieces. The darkened borders are seen, with the inwardly fading white deposits, and the mortar areas are obscured by gel. Shrinkage cracks in the gel may be seen inside the air void appearing in Fig. 12.

Figures 13 and 14 show a concrete not previously illustrated. This is a 1935 construction in Georgia. The coarse aggregate seen in Fig. 13 and in the upper half of Fig. 14 is chert. Note in each case that the fracture surface passes through the aggregate. There is the narrow dark border, the thin white film fading inwardly, and the transverse cracks that narrow and terminate in the border. Mortar areas are covered with a nearly clear gel, seen especially in Fig. 14.

Across the bottom of Fig. 14 a piece of quartz aggregate is seen. Another piece of quartz is shown in Fig. 15, this one from the same New York concrete shown in Fig. 5. Both of these pieces of quartz show secondary features similar to those seen in the chert.

*Discussion.*—As has been noted in these photographs, the fracture surface tends to pass through rather than around the pieces of altered aggregate. This evidently is because of the preexisting internal fractures generated in the course of alteration and observed in the illustrations of plane-cut surfaces. This feature often is easily perceivable

Fig. 10

Fig. 11

Fig. 12

Fig. 13

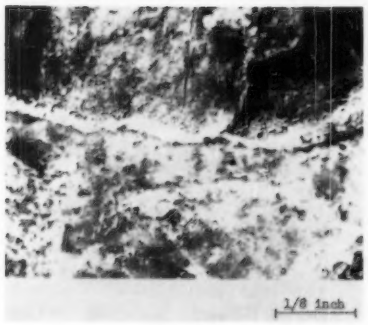



Fig. 14

by the unaided eye, because of the gross dimensions of coarse aggregate. Mather provides an excellent illustration in Figs. 8 and 9 of his paper (**4**). It often should be possible therefore in the field examination not only to perceive alteration but also to recognize it as a source of mechanical displacement.

Figure 16 may be shown in illustration. This is concrete from a 1901 construction in Idaho. Cracking observed on external surfaces of this structure was in an unusual rectangular block pattern, some 6 in. or more in dimension. The photograph shows a section through a piece removed from the structure. The strip along the base is irrelevant, this being a quick-setting cement in which the piece was squared up for cutting the section. For some reason the coarse aggregate, a crushed stone, was not uniformly distributed. Concentrations of coarse aggregate appear along the upper and lower boundaries seen in the section. The old cracks in the structure passed through these concentrations and also through the individual pieces. Actually it was the enlargement of these pieces that caused the cracking; the pieces otherwise show the features typical of alkali attack. The concrete or mortar between these concentrations of aggregate is in perfect condition.

## General Discussion

As observed in the variety of instances illustrated, damage by alkali-aggregate reaction appears to be effected by direct enlargement of the affected aggregate units. This conclusion also is variously found in the literature. Stanton described popouts (**2**) with gel at the base; he later noted cracks in an experimental specimen, radiating from an affected aggregate particle (**3**). Mielenz and Witte (**5**) in their Fig. 12 show ramifying cracks about an aggregate particle. Rhoades and Mielenz (**6**) in their Fig. 19 note cracks radiating from opal grains. Vivian (**7**) writes: "The reacting particles swell on absorbing water and produce cracks in the mortar." As thus illustrated, the mechanics of expansion of concrete by alkali-aggregate reaction appear to be basically simple. The mechanism appears to be effectively analogous to that in the expansion of concrete by hydration of hard-burned lime or magnesia, or by sulfate attack on aluminates, or by rusting of reinforcing steel as occurs sometimes from insufficient cover.

There is good reason why this basic simplicity often is not more readily apparent. Usually the simple relations are complicated or confused by other features or properties of concrete.

In the first place, the tell-tale cracks outside of and radiating away from the affected aggregate, so well illustrated in Fig. 1, often are unperceivable, if present at all. There appear to be two reasons for this condition: (1) Concrete possesses in some measure the property of plastic deformation. With long-time, slow development of pressure, especially about small constituent units, there may be plastic accommodation without fracture. Consider, for example, Fig. 17, showing a portion of a polished section from concrete in a field structure. The bright center detail is a particle of cement as yet unhydrated. The two dark rounded bodies within were free lime, now hydrated. The radiating cracks through the cement particle show that the free lime, in hydrating, has enlarged, exerted pressure, and caused displacement. Yet there is no visible continuation of the cracking in the surrounding hydrated cement paste or mortar.

Fig. 15

(2) Expansion of concrete, as by alkali-aggregate reaction, often is general and on a minute scale, down to dimensions far below those of the aggregate particles, even the sand grains. The cause of this general expansion is as yet not fully known, but the effect is to compensate or eliminate localized stresses so that cracks do not appear about pieces of affected aggregate, even though other features show that they have expanded. For illustration consider Fig. 18. Here a small piece of shale shows the darkened rim and internal cracks but no external fractures. This concrete is from a New York structure. The structure shows nearly 0.1 per cent over-all expansion, yet intensive study of many samples yielded no better illustration of alteration-displacement relations than that shown here. The evidence of expansion is positive despite the absence of external cracks, which are lacking be-

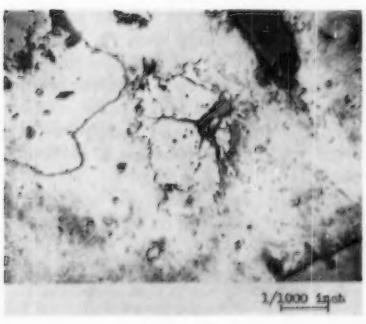



Fig. 16

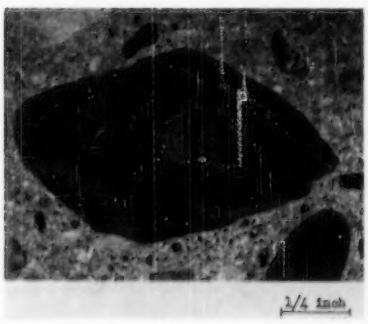



Fig. 17

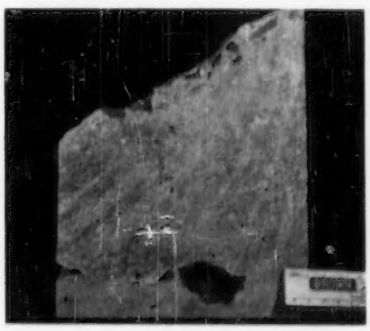


Fig. 18

cause of a general and fine-scale distribution of the over-all expansion.

A second complicating factor in perceiving direct enlargement of the aggregate is the confusion introduced by the apparent mobility of the gel. Fracture surfaces offer the readiest means of examination of concrete, and these, as made available for inspection, tend to follow fractures long existent in the structure. Since the gel tends to be distributed along the walls of these old fractures, the net result is that other structural features are obscured, and a greatly disproportionate impression of the prominence or significance of the gel is created, as may be noted by comparison between cut and fractured surfaces on the same concrete.

This apparent prominence, coupled with other unique features of the gel, led to postulation of hydrostatic pressure from osmosis (**8**) as the source of the force by which alkali-aggregate reaction causes expansion of concrete. While it may be that osmotic processes are involved in the unit enlargements here illustrated, it does not appear that the gel concentrations visible in the old fractures have been under high hydrostatic pressure, for the gel concentrations occur only in the mortar portions and not within the continuations of the same fractures through the affected aggregate. The indication is rather that the damage has been done before the fluid gels appeared.

Another complication enters from the fact that concretes rarely are free from the action of other damaging agents, with distress patterns that may appear to be wholly similar. Such agents include temperature and humidity cycles, frost action, subgrade settlement, load concentrations, sulfate exposure, etc. Initial damage by any one of these, or by alkali-aggregate reaction, serves to initiate or to accelerate activity of the others.

In this situation it may be difficult to decide which particular agent effected the initial damage. On the other hand, close study of displacement patterns usually will point out individual contributors. Utilizing this approach the evidence may prove that alkali-aggregate alteration has been a cause of displacement, as has been shown in the illustrations offered in this paper. Furthermore, insofar as alkali-aggregate reaction has been shown to be involved, the combined evidence of displacement and aggregate alteration has shown that its contribution is made through direct enlargement, in place, of the affected pieces of aggregate.

### References


(1) Thomas E. Stanton, "Influence of Cement and Aggregate on Concrete Expansion," *Engineering News-Record*, Vol. 124, p. 171 (1940).

(2) Thomas E. Stanton, "Expansion of Concrete Through Reaction Between Cement and Aggregate," *Proceedings*, Am. Soc. Civil Engrs., Vol. 66, pp. 1781–1811 (1940); with discussion, *Proceedings*, Am. Soc. Civil Engrs., Vol. 107, pp. 54–126 (1942).

(3) Thomas E. Stanton, "Expansion of Concrete Through Reaction Between Cement and Aggregate," *Proceedings*, Am. Soc. Civil Engrs., Vol. 67, pp. 1402–1418 (1941).

(4) Bryant Mather, "Cracking of Concrete in the Tuscaloosa Lock," *Proceedings*, Highway Research Board, Vol. 31, pp. 218–233 (1952).

(5) R. C. Mielenz and L. P. Witte, "Tests Used by the Bureau of Reclamation for Identifying Reactive Concrete Aggregates," *Proceedings*, Am. Soc. Testing Mats., Vol. 48, p. 1071 (1948).

(6) Roger Rhoades and R. C. Mielenz, "Petrography of Concrete Aggregate," *Proceedings*, Am. Concrete Inst., Vol. 42, p. 581 (1946).

(7) H. E. Vivian, "Studies in Cement-Aggregate Reaction, Parts XI and XII," *Bulletin No. 256*, Commonwealth Scientific and Industrial Research Organization, Melbourne (1950).

(8) W. C. Hansen, "Studies Relating to the Mechanism by Which the Alkali-Aggregate Reaction Produces Expansion in Concrete," *Proceedings*, Am. Concrete Inst., Vol. 40, p. 213 (1944).


## DISCUSSION

Mr. M. A. Swayze.[1]—I should like to compliment Mr. Brown for his very clear and logical treatment of this subject in which there has been so much mystery involved. There are two points underemphasized in the text which seem to me of prime importance.

The first of these concerns Fig. 1. The two cracks running across the principal piece of coarse aggregate are completely empty and clean. This means that there had been essentially no pressure from the outside after these cracks were formed, or gel would have been forced into them and have remained in part during cutting of the section.

The second point is that this white or colorless gel which is so frequently credited with being the direct cause of the expansion in alkali-aggregate reaction is really a secondary and unimportant feature. The true cause of expansion is tersely given in the last paragraph of Mr. Brown's paper and cannot be overemphasized: "Insofar as alkali-aggregate reaction has been shown to be involved, the combined evidence of displacement and aggregate alteration has shown that *its contribution is made through direct enlargement, in place, of the affected pieces of aggregate.*" In other words, it is the direct swelling of these hard aggregate particles by the action of alkali on them that causes the expansion, rather than the relatively soft gel which is later leached out by water and deposited in the cracks already formed by swelling of the solid particles of aggregate. By so clearly demonstrating the true sequence of these actions, Mr. Brown has made a very important contribution to our knowledge.

Mr. W. C. Hansen[2] (*by letter*).—Mr. Brown has presented a very interesting paper, and the photomicrographs of different aspects of the alkali-aggregate reaction are very good. However, I cannot agree with his conclusion that the observed displacement relations do not accord well with the hypothesis that damage is due to hydrostatic pressure. In my opinion, there is very little in the evidence presented by Mr. Brown that is directly useful in studying the hydrostatic pressure hypothesis.

He points out that Vivian, from his studies, reached the conclusion that "the reacting particles swell on absorbing water and produce cracks in the mortar."[3] Mr. Brown states: "Photomicrographs of varied occurrences indicate that damage by alkali-aggregate reaction is effected essentially by direct enlargement of the aggregate units." I made the following statement: "Since the alkali-silicates must form in the space originally occupied by the silica from which they were formed, and since these silicates must occupy a greater volume than that occupied by the silica alone, they would tend to exert pressure against the confining paste, which would be augmented by the hydrostatic pressure." (See reference **8** of Brown paper.)

All three statements are based on a reaction of either all or some part of an

[1] Director of Research, Lone Star Cement Corp., New York, N. Y.

[2] Manager, Research Laboratories, Universal Atlas Cement Co., Gary, Ind.

[3] H. E. Vivian, "Studies in Cement-Aggregate Reaction," Part XV, *Bulletin No. 256*, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia (1950).

aggregate with an alkali. Vivian and Brown are indefinite as to the mechanism by which the aggregate particle takes up water and enlarges.

One experiment described in my paper seems pertinent with respect to these three statements. In that experiment, broken faces of prisms made with particles of silica-gel as aggregates were examined. The particles, as seen in these faces, appeared to have been unaltered during four months as aggregates in concrete. However, when they were probed with a needle, they were found to have been changed to a jelly-like material which was readily soluble in water.

The examination under low magnification revealed nothing as to what had happened to these particles. However, probing with a needle showed that they had reacted in some manner with some components of the cement paste and, since they were soft, it seemed that they must have imbibed water. No direct evidence was obtained to show that they had expanded. However, probably no one would question the conclusion that the reacting particles absorbed water and that there had been direct enlargement of the aggregate units.

The absorption of water was explained on the basis that relatively soluble alkali silicates were formed on one side of a semipermeable membrane and drew water to them by osmosis. It was then concluded that this process would cause the reaction products of aggregate and alkali hydroxide to exert a pressure against this semipermeable membrane, cement paste. Since water was drawn into this space by osmosis, the pressure could be referred to as either osmotic or hydrostatic pressure. This explanation did not specify any particular degree of fluidity for the alkali silicate solution or gel, if one objects to applying the word "solution" to a gel-like product.

Kalousek, in a discussion of the Hansen paper (**8**), suggested that the hardened cement paste might, of itself, not meet the requirements of a semipermeable membrane and suggested that the membrane was a reaction product of alkali silicates and calcium hydroxide. Vivian[3] concluded from certain experiments that such a reaction product did not function as a semipermeable membrane for this reaction and that a semipermeable membrane was not required for the expansion of concrete by the alkali-aggregate reaction. He states: "The reason why a membrane is not required is revealed by the nature of gels. Furthermore, the lack of large volumes of water in contact with reacting opal probably explains why the reaction product remains for a time in the gel state, and does not disperse rapidly." This does not explain the presence of pockets of highly fluid alkali silicate solutions in some specimens of concrete, and Vivian has not shown that hardened cement paste does not function as a semipermeable membrane.

Brown attempts to draw conclusions pertaining to internal pressures from the appearance of cracks in the aggregates and pastes. He states: "Bulk enlargement of shell also tends to put the interior in tension." He apparently believes that an alkali-aggregate reaction enlarges the particle and applies a pressure to the surrounding paste. Regardless of the mechanism by which the reaction products are confined to the site of their formation, it is difficult to visualize how these products could exert a pressure against the confining paste without exerting an equal pressure against the underlying aggregate. On the other hand, cracks in aggregates which appear to be produced by tension are readily explained by the manner in which concrete cracks.

Most, if not all, of the cracking of concrete produced by internal pressures originates at the surface of the structure or specimen. The cracking of a specimen in which an internal pressure is being produced by reactions such as the hydration of calcium and magnesium oxides and the alkali-aggregate is similar to that produced when a specimen containing a piece of reinforcing steel is dried. The concrete cracks at the surface and the cracks proceed toward the reinforcing steel in the one case and toward the source of the expansion in the other. If certain aggregates in the path of the crack have low tensile strengths and adhere strongly to the cement paste, they are likely to be torn apart. If the crack passes through a pocket of highly fluid gel, it might become filled with gel. Hence, in some cases, the cracks in such aggregates might remain empty and in others become filled with gel.

Brown points out that, from the examination of the gels in such cracks, there is no evidence that the gels were under hydrostatic pressure. This is, of course, correct because the gels flowed freely from their source, where they were under pressure, into cracks after the cracks were formed.

The reason for Brown and Vivian's argument against the production of hydrostatic pressures by the alkali-aggregate reaction appears to be that they have assumed that such pressures can be produced only by highly fluid liquids. There seems to be no reason for not applying this name to pressures produced by highly viscous gel-like products which swell by inhibition of water. Brown states that osmotic processes may be involved in the enlargement of aggregates. Hence, if he would agree that the gel-like products formed in this enlargement could produce osmotic or hydrostatic pressures, we probably would be in agreement as to the mechanism involved when the alkali-aggregate reaction produces expansion in concrete.

MR. W. C. HANNA[5] (*by letter*).—The figures of both polished sections and rough breaks are very good and would certainly appear to offer definite proof that cracking or expansion of concrete may be caused by a reaction between the aggregate and the cement matrix.

There are, however, several points that I would question or like to see amplified. First, in the title and in the synopsis of this paper, reference is made to an alkali-aggregate reaction. If interpretation of the word "alkali" includes lime, fine; if not, I think the word has been incorrectly used. Actually, in the paper there are no data on the composition of the reaction zones that would justify calling it anything.

Second, I would like to call attention to the fact that the dark films or "rings" around the aggregate are frequently found on aggregate that has never been in contact with cement matrix. Therefore, some doubt could exist regarding any interpretation of these dark areas as being deleterious reaction zones.

Third, I would like to inquire if any attempt was made to ascertain the original alkali content of the cements used in the various specimens. Was it low, meaning less than the arbitrary 0.6 per cent, or was it high? Such information I believe to be very important in studies of this over-all problem.

In conclusion, I want to compliment the author for his fine paper and also for his appreciation of the fact that many other damaging agents may be involved in cases of excessive expansion.

MR. L. S. BROWN (*author's closure*).—The author wishes to thank Messrs. Swayze, Hansen, and Hanna for their valued comments.

From Mr. Hansen's discussion it appears that the purpose of the paper was not made fully clear. Question or detailed discussion of the osmotic pressure hypothesis was not intended. The purpose was simply to describe and illustrate visual features distinctive of damage by alkali-aggregate reaction. Deference to prior literature on the subject made it necessary to state that the gel segregations, at least those more prominent and more readily recognizable as such, did not appear to have been under hydrostatic pressure. Osmotic

[5] Vice-President in Charge of Technical Development, California Portland Cement Co., Colton, Calif.

processes as a source of force were not necessarily thereby called into question, and it also was stated that osmotic processes might be involved in the enlargement of the aggregate units. It is simply that according to present observation the pattern of dislocation does not indicate the moving forces, of osmotic or other origin, to have acted hydrostatically.

Mr. Hanna notes a lack of compositional data. In a way, that is correct. Perhaps each photograph should bear a point indicating where a microscopic sample was taken, and the corresponding text the optical properties observed. Actually such tests were made, as indicated in the early portion of the paper, though generally not from fields specifically shown in the photographs. Compositional features of the substances are established through determination of optical properties. That means of course prior linkage of optical properties of a substance with its composition as determined chemically.

This is possible to accomplish and has been done for alkali-aggregate reaction in only those few cases where advanced development has permitted segregation of gel in an abundance permitting sampling adequate for intelligible analyses. These analyses have shown essentially alkali, silica, and water. Corresponding optical properties are amorphous structure, isotropic character, and a refractive index ranging from 1.43 to 1.47, depending apparently upon the proportions of alkali and water to silica. Once this relation has been established, the identity of an unknown may be established simply by noting its optical properties. In most cases of alkali-aggregate reaction it is the only means of identification, for the state of development is so meager that a sample suitable for an intelligible chemical analysis cannot be obtained.

To the extent of present knowledge, lime has no physically deleterious part in the reaction. The amorphous, isotropic gels have not been known to occur in concrete systems where alkali was known to be low. With the exception of fluorite, no lime compound, isotropic and with refractive index below 1.48, is known. One may venture further the suggestion that, if lime were capable of a mechanically deleterious reaction, concrete as we know it would not now exist, for lime is always present in abundance, and concretes from the beginning of concrete technology have been made with siliceous aggregates.

Mr. Hanna also inquires about the alkali content of the cements. For most of the cases shown here, that is not known, and commonly for field occurrences that may be encountered it will not be known, partly because construction records may not be available or be incomplete in detail and partly because usually the structures will have been constructed in times prior to determination of alkalies in cements.

# Additional Nomographs for Significance Tests

By Chou Hsiung Li

***Nomographs for evaluating the significance of attributive test results on two large equal-size samples may give unbiased conclusions of known reliability for research, managerial, or engineering personnel.***

THIS paper presents three additional nomographs for evaluating the significance of attributive test results on two equal-size samples. These graphs cover sample sizes from 80 to 100,000.

The new charts are extensions of the nomograph given in an earlier paper published in the December, 1953, ASTM BULLETIN.[1] In the original nomograph, the sample size ranged from 8 to 100. Since its publication, various industrial and research organizations have requested graphs for larger samples. The new nomographs were constructed as follows:

Equation 2 in the paper previously published reads

$$v' = \frac{(d_A - d_B) - 1}{\sqrt{(d_A + d_B)\left(1 - \frac{d_A + d_B}{2n}\right)}} = \frac{D - 1}{\sqrt{S\left(1 - \frac{S}{2n}\right)}} \quad \ldots\ldots\ldots (2)$$

for $d_A > d_B$.

If $a$ is any positive number, the substitution of $n' = an$, $S' = aS$, and $D' = \sqrt{a}(D-1) + 1$ for $n$, $S$, and $D$, respectively, in Eq 2 leaves the value of $v'$ unchanged.

In other words, if the figures on both the $n$-scale and the $S$-scale in the original $n$-$D$-$S$ chart[1] are multiplied by $a$ to give the $n'$ and $S'$ scales of a new $n'$-$D'$-$S'$ chart, the positions of these new $S'$-scales are exactly the same as before, provided the new $D'$-scale is so plotted that

$$X_{D'} = 0, \text{ and}$$

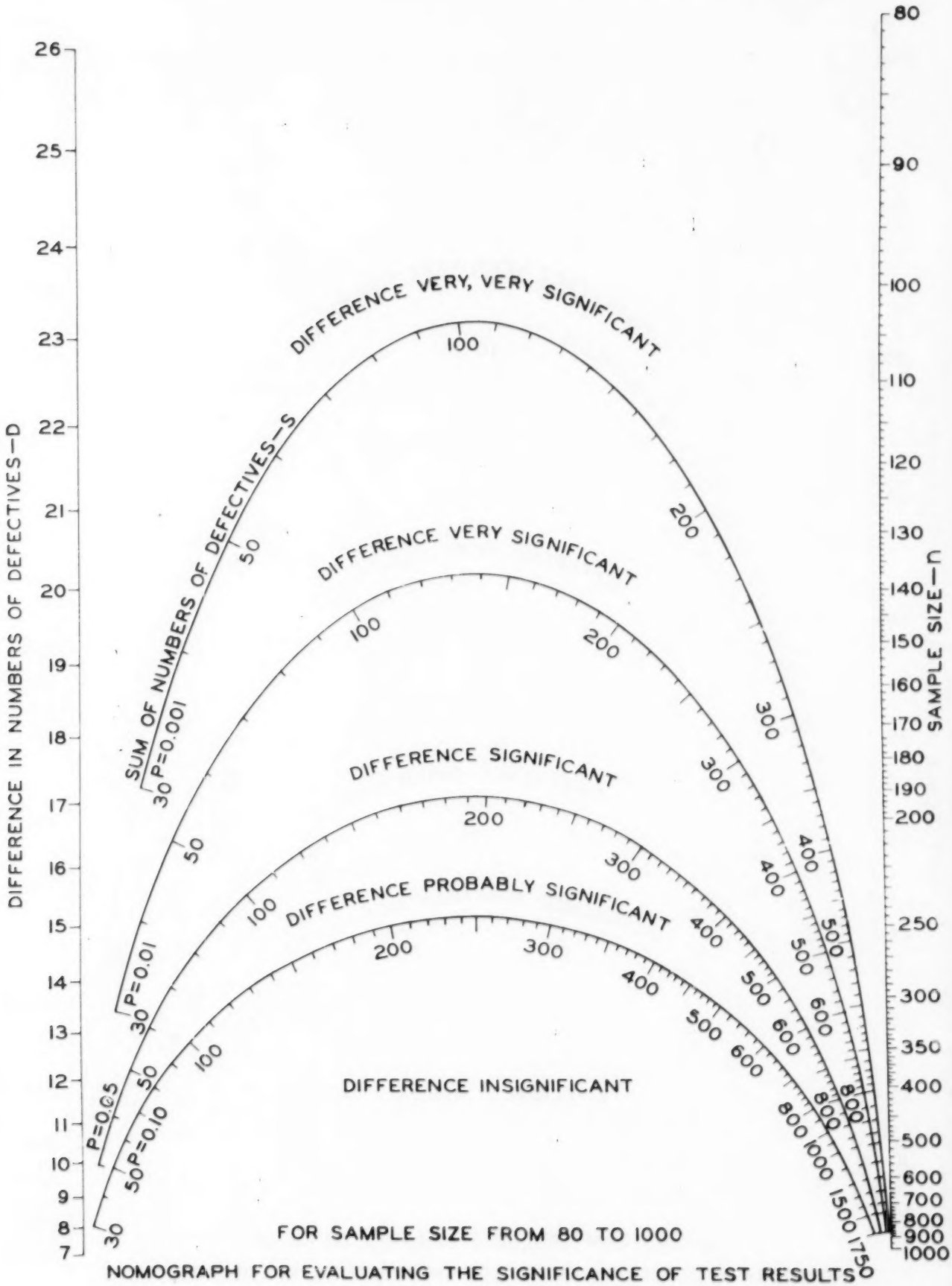
$$Y_{D'} = \frac{r\,(D - 1^2 - d_1 - 1^2)}{d_2 - 1^2 - d_1 - 1^2} = \frac{r\left(\frac{D' - 1^2}{a} - d_1 - 1^2\right)}{d_2 - 1^2 - d_1 - 1^2}$$

Thus, nomographs for different sample sizes ($n' = an$) may be produced from the original nomograph $n$-$D$-$S$ in accordance with the above procedure. The three nomographs presented in this paper were produced from the nomograph previously published[1] (sample size $n$ from 8 to 100) using values for the constant $a$ of 10, 100, and 1000, respectively.

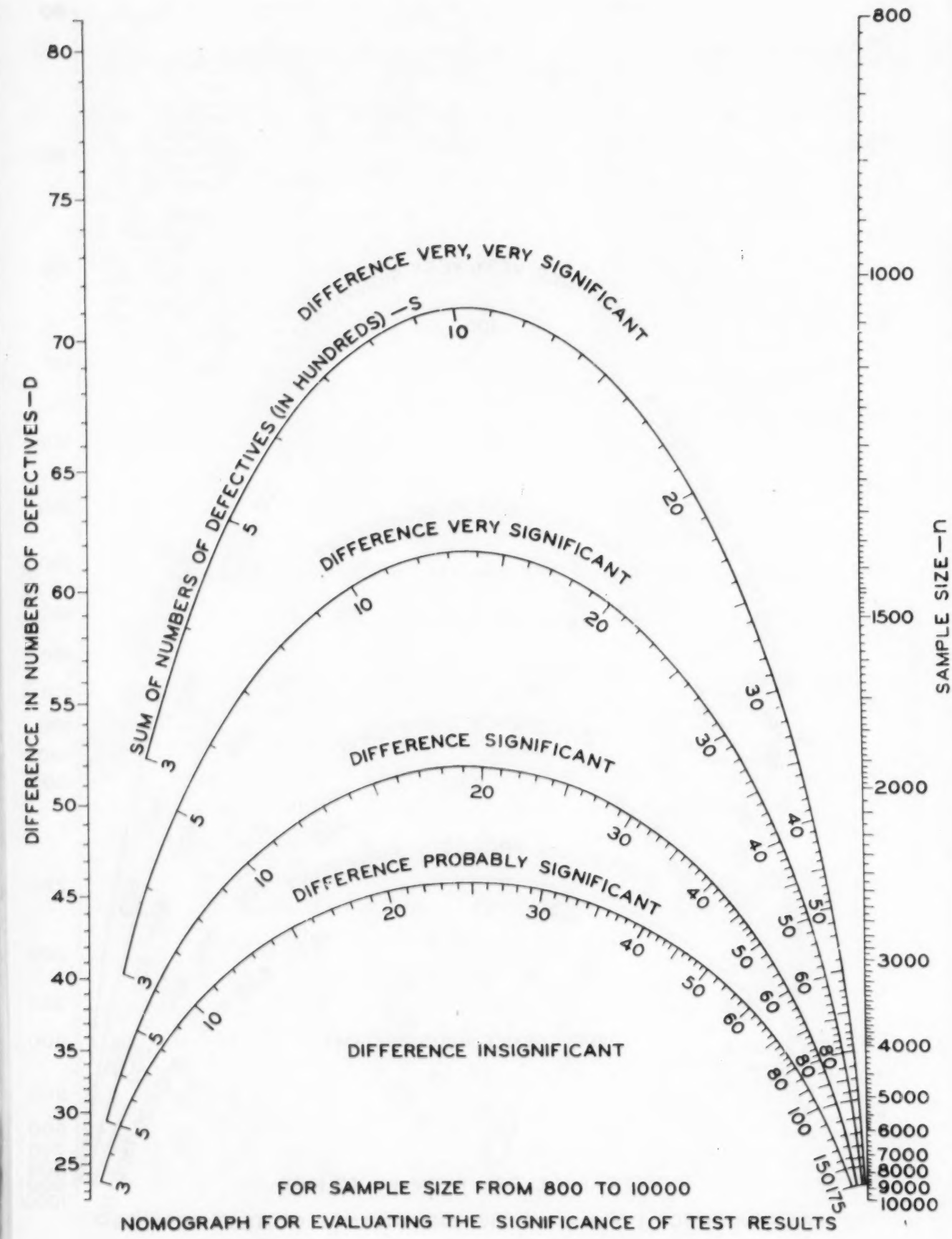
**C. H. LI, Metallurgist, Radio Corporation of America, Harrison, N. J., has since 1951 engaged in work on controlled experiments for Chemical and Physical Laboratory, RCA Tube Division at Marion, Ind., and Harrison. He has designed experiments on hot hardness, steel chromizing, electrolytic plating, and brewery waste disposal in connection with graduate studies.**

**NOTE.**—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Chou Hsiung Li, "A Nomograph for Evaluating the Significance of Some Test Results," ASTM BULLETIN, No. 194, December, 1953, p. 74 (TP218).

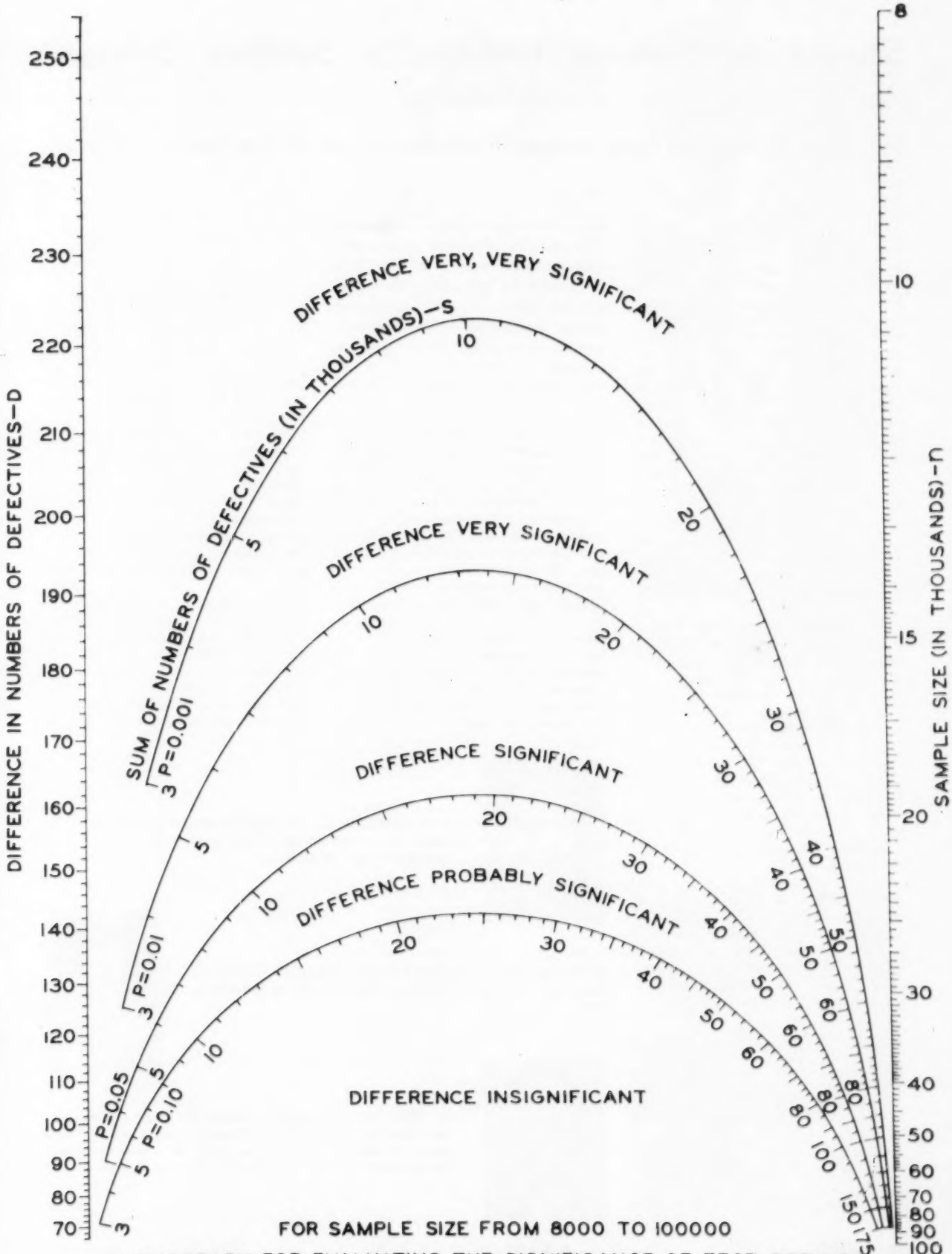



NOMOGRAPH FOR EVALUATING THE SIGNIFICANCE OF TEST RESULTS




NOMOGRAPH FOR EVALUATING THE SIGNIFICANCE OF TEST RESULTS

NOMOGRAPH FOR EVALUATING THE SIGNIFICANCE OF TEST RESULTS




NOMOGRAPH FOR EVALUATING THE SIGNIFICANCE OF TEST RESULTS

# Silicates as Corrosion Inhibitors in Synthetic Detergent Mixtures*

By Raymond Getty, Newton W. McCready, and William Stericker

***The addition of certain sodium silicates reduces corrosion or tarnishing of metals by household detergent mixtures containing polyphosphates. Copper and properly chosen enamels are resistant to corrosion by these detergent solutions.***

EARLY in the development of synthetic household detergents it was found that some of the mixtures corroded aluminum. Since it was known that soluble silicates prevented the attack of alkaline detergents on aluminum and its alloys,[1,2] some silicate was added to these mixtures. Even small amounts of soluble silicates largely or entirely prevented the attack upon aluminum. Since then it has been noticed that even these mixtures, which are reasonably safe on aluminum, attack other metals and alloys and enamels and glazes. The present work was undertaken to find out whether the corrosion of these other materials could be inhibited by the use of soluble silicates.

Evidence of attack was seen not only in the case of materials being washed, but also, and perhaps more markedly, in the parts of machines used for washing dishes and clothes. Cases of severe corrosion have been noticed, particularly in connection with the zinc alloys. One example of this, shown in Figs. 1 and 2, is a spindle taken from a domestic washing machine. It will be noticed that corrosion has been severe on all four sides and has actually eaten through in several places. If soap had been used in this washer, the metal would have been protected by a very thin film of calcium and magnesium soaps, or possibly even by some zinc soap. No such film was formed with a synthetic detergent, so the corrosion damage was severe.

In some cases the corrosion has been increased by the use of improper metals and combinations of metals. For example, one washing machine is made in which there is a copper collar directly in contact with an aluminum spindle. It was suggested to this manufacturer that the machine be designed to eliminate this combination and that in the meantime a nonconducting layer be placed between the two metals, but, over a period of several years, this has not been done and corrosion of the aluminum parts continues to be severe. Apparently the machine manufacturer feels, in this case at least, that the detergent manufacturer should give him something that will protect his machine no matter what he does.

The object of the tests reported here was to determine the degree of corrosion with some detergent solutions, and the degree of protection obtained by the addition of various amounts of various silicates. Tests were made with aluminum, zinc, copper, brass, nickel silver, and several enamels.

## Experimental Procedure

*Method:*

Metal disks approximately 1.5 in. in diameter with center holes about 0.25 in. were received as stampings. They were cleaned by successive immersion in carbon tetrachloride, methanol, warm tap water, distilled water, and finally acetone. They were then oven dried and weighed to the nearest 0.1 mg. In most cases, six of these disks were mounted on a glass rod. They were held in place and separated from each other by small pieces of rubber tubing. Five of these rods were attached to a Phipps & Bird laboratory stirring machine. Each rod was immersed in a separate beaker holding the test solution and rotated at 50 rpm.

Stock solutions of the synthetic detergent and the silicate were used, while the phosphates were added as weighed portions. Sufficient hot distilled water was used to give a total volume of 720 ml. Coated glass beakers were used and placed in a water bath maintained at 60 C. When more or less than six

RAYMOND GETTY with the Philadelphia Quartz Co. for 25 years, is a member of the research group in which he has done considerable work on detergents.

N. W. McCREADY, Research Manager, Philadelphia Quartz Co., since 1949, received his Ph.D. from the University of California in 1941.

W. STERICKER, Development Chemist, Philadelphia Quartz Co., has worked on cleaning and inhibiting corrosion of metals for many years. A member of D-12 since 1942, he is now chairman of Subcommittee S-4 on Specifications for Alkaline Detergents.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at a meeting of ASTM Committee D-12 on Soaps and Other Detergents, New York, N. Y., March 23, 1954.

[1] James G. Vail, "Soluble Silicates," *Monograph No. 116*, Am. Chemical Soc., Reinhold Publishing Corp., New York, N. Y. (1952).

[2] Jay C. Harris, "Metal Cleaning Bibliographical Abstracts," Am. Soc. Testing Mats. (1949). (Issued as separate publication *ASTM STP No. 90*.)

disks were used, a proportionately larger or smaller amount of solution was used so as to maintain a ratio of 1.5 sq dm of metal surface per liter of solution.

The samples for the determination of pH were removed from the beakers immediately before and after the tests. The pH was determined after the solutions had cooled. Since it was felt that solutions in washing machines were completely saturated with air, air was bubbled through the beakers throughout the corrosion test. The air was first passed through 3 per cent sodium hydroxide to remove the carbon dioxide, and then bubbled through hot water at 60 C to humidify and warm it. The air flow was maintained at approximately 200 cu cm per min.

The tests were run for 2 hr. At the end of that time, the disks were removed from the test solutions, rinsed in running warm tap water, then in methanol, and finally in acetone. They were then dried and weighed as they had been before the test. The loss in weight was converted to milligrams per square decimeter. One milligram per square decimeter is equivalent to from 0.1 to 0.15 mg, varying somewhat with the density and thickness of the disks.

*Materials Used:*

Most of the tests were made with Nacconol HG,[3] which is an alkyl-aryl sulfonate with 41.0 per cent sodium sulfate. A few tests were made with sodium Oronite[4] containing approximately 60 per cent sulfonate. No difference in corrosion results were noticed between these two materials.

The phosphates were commercial anhydrous powders. The sodium tripolyphosphate was made by Victor Chemical Works and the tetrasodium pyrophosphate came from Westvaco Chemical Division, Food Machinery and Chemical Corp.

The sodium silicates used were commercial products with the analyses shown in Table I.

[3] National Aniline and Chemical Division, Allied Chemical and Dye Corp.

[4] Oronite Chemical Co.

The first three of these are solutions of colloidal silicates. The last two are commercial sodium metasilicate pentahydrate and hydrated sodium sesquisilicate, respectively.

## Experimental Results

*Aluminum:*

The first tests were made with aluminum which contained at least 99.0 per cent aluminum, not over 1 per cent silicon and iron, and about 0.2 per cent copper and 0.10 per cent manganese. This is alloy 990A in ASTM Specification B 209.[5] The results are given in Table II.

The alkyl-aryl sulfonate together with the sodium sulfate it carried did not attack the aluminum at a concentration of 0.20 per cent. The addition of the colloidal silicates (the first three in Table I) did not cause any change in weight or appearance of the disks. There was a slight dulling of the metal surface with sodium metasilicate, and a small but measurable loss in weight (3.5 mg per sq dm) with 0.14 per cent silicate solids, but no change with 0.04 per cent metasilicate. When either sodium tripolyphosphate or tetrasodium pyrophosphate was added to the sulfonate, the aluminum showed marked attack. In 2 hr at 60 C, the losses in milligrams per square decimeter were 57 and 93, respectively. With both phosphates the aluminum surfaces were dulled and etched, and there was some discoloration and pitting. The addition of 0.04 to 0.2 per cent silicate solids practically eliminated all the weight loss with either phosphate. The three most siliceous silicates protected the appearance of the metal surfaces, but the metasilicate mixtures permitted slight dulling.

These tests were run at a total detergent concentration of 0.4 to 0.6 per cent. The question was raised whether similar results would be obtained at lower concentrations, such as might be found under hand dishwashing conditions. A second series of tests at lower

[5] Tentative Specifications for Aluminum and Aluminum-Alloy Sheet and Plate (B 209 – 52 T), 1952 Book of ASTM Standards, Part 2, p. 579.

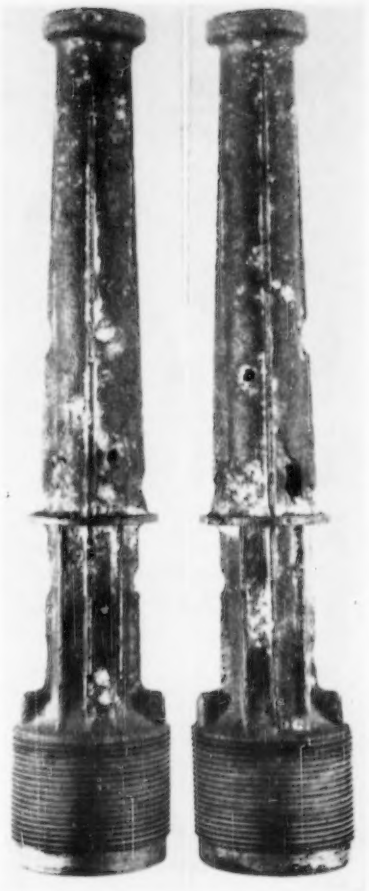


Fig. 1.—Obverse and Reverse of Spindle From Home Washing Machine Showing Corrosion.

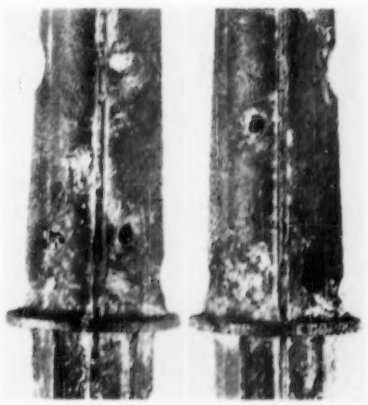


Fig. 2.—Closer Views of the Same Spindle Showing Holes and Over-all Damage Due to Corrosion.

TABLE I.—ANALYSES OF SODIUM SILICATES USED IN TESTS.

| Designation[6] | Sodium Oxide, per cent | Silicon Oxide, per cent | Total Silicate Solids, per cent | Percentage Ratio | Molecular Ratio |
|---|---|---|---|---|---|
| N | 8.87 | 28.76 | 37.63 | 1:3.242 | $Na_2O:3.358SiO_2$ |
| RU | 13.58 | 33.46 | 47.04 | 1:2.464 | $Na_2O:2.548SiO_2$ |
| BW | 19.46 | 31.66 | 51.12 | 1:1.627 | $Na_2O:1.688SiO_2$ |
| Metso Granular | 29.52 | 28.15 | 57.67 | 1:0.952 | $Na_2O:0.988SiO_2$ |
| Metso 99 | 36.21 | 24.61 | 60.82 | 1:0.680 | $3Na_2O:2.108SiO_2$ |

[6] Registered trade marks of the Philadelphia Quartz Co.

TABLE II.—EFFECT OF ALKYL-ARYL SULFONATE, SILICATES, AND POLYPHOSPHATES ON 99.0A ALUMINUM AT 60 C.

| Nacconol HG, per cent | Silicate Solids, per cent | Phosphate, per cent | Loss in Weight, mg per sq dm | pH of Solution | Remarks |
|---|---|---|---|---|---|
| 0.2 | None | None | 0 | 6.5 | Appearance of metal unchanged |
| 0.2 | 0.04 N | None | 0 | 9.6 | Appearance of metal unchanged |
| 0.2 | 0.14 N | None | 0 | 10.1 | Appearance of metal unchanged |
| 0.2 | 0.08 RU | None | 0 | 10.2 | Appearance of metal unchanged |
| 0.2 | 0.2 RU | None | 0 | 10.5 | Appearance of metal unchanged |
| 0.2 | 0.08 BW | None | 0 | 10.6 | Appearance of metal unchanged |
| 0.2 | 0.2 BW | None | 0 | 11.1 | Appearance of metal unchanged |
| 0.2 | 0.04 Metso Granular | None | 0 | 11.1 | Metal slightly dulled |
| 0.2 | 0.14 Metso Granular | None | 3.5 | 11.8 | Metal slightly dulled and grayer |
| 0.2 | None | 0.2 tripoly | 57 | 9.1 | Metal dull and gray with etching and some pitting |
| 0.2 | 0.04 N | 0.2 tripoly | 0 | .... | Appearance of metal unchanged |
| 0.2 | 0.14 N | 0.2 tripoly | 0 | 10.1 | Appearance of metal unchanged |
| 0.2 | 0.056 RU | 0.2 tripoly | 1 | 9.8 | Appearance of metal unchanged |
| 0.2 | 0.196 RU | 0.2 tripoly | 0 | 10.3 | Appearance of metal unchanged |
| 0.2 | 0.08 BW | 0.2 tripoly | 2 | 10.4 | Appearance of metal unchanged |
| 0.2 | 0.2 BW | 0.2 tripoly | 2 | 11.0 | Appearance of metal unchanged |
| 0.2 | 0.08 Metso Granular | 0.2 tripoly | 0 | 11.1 | Metal slightly dulled |
| 0.2 | 0.2 Metso Granular | 0.2 tripoly | 0 | 12.0 | Metal slightly dulled |
| 0.2 | None | 0.2 pyro | 93 | 9.6 | Metal dull and gray with etching and some pitting |
| 0.2 | 0.04 N | 0.2 pyro | 0 | 9.8 | Appearance of metal unchanged |
| 0.2 | 0.08 N | 0.2 pyro | 1 | 9.9 | Appearance of metal unchanged |
| 0.2 | 0.2 N | 0.2 pyro | 0 | 10.3 | Appearance of metal unchanged |
| 0.2 | 0.112 RU | 0.2 pyro | 0 | 10.1 | Appearance of metal unchanged |
| 0.2 | 0.28 RU | 0.2 pyro | 0 | 10.6 | Appearance of metal unchanged |
| 0.2 | 0.04 BW | 0.2 pyro | 0 | 10.0 | Appearance of metal unchanged |
| 0.2 | 0.14 BW | 0.2 pyro | 2 | 10.8 | Appearance of metal unchanged |
| 0.2 | 0.04 Metso Granular | 0.2 pyro | 1 | 10.7 | Metal slightly dulled |
| 0.2 | 0.14 Metso Granular | 0.2 pyro | 0 | 11.8 | Metal slightly dulled |

TABLE III.—CORROSION OF M1A ALUMINUM BY DETERGENT SOLUTIONS IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| **Tests with 0.2 per cent Nacconol Plus Indicated Silicate** | | | | | |
| N | 0 | 0 | .. | 0 | .. |
| RU | 0 | .. | 0 | .. | 0 |
| BW | 0 | .. | 6 | .. | .. |
| Metso Granular | 0 | 3 | .. | 4 | .. |
| Metso 99 | 0 | .. | .. | .. | 7 |
| **Tests with 0.2 per cent Nacconol Plus 0.2 per cent $Na_4P_2O_{10}$ Plus Indicated Silicate** | | | | | |
| N | 66 | 3 | .. | 0 | .. |
| RU | 66 | 0 | −1[a] | −1[a] | 0 |
| BW | 66 | −2[a] | 1 | 0 | .. |
| Metso Granular | 66 | .. | 0 | .. | 1 |
| Metso 99 | 66 | 12 | .. | 19 | .. |
| **Tests with 0.2 per cent Nacconol Plus 0.2 per cent $Na_4P_2O_7$ Plus Indicated Silicate** | | | | | |
| N | 108 | .. | 1 | .. | 0 |
| RU | 108 | 1 | 1 | 0 | 0 |
| BW | 108 | 0 | .. | 0 | 0 |
| Metso Granular | 108 | 1 | .. | 0 | .. |
| Metso 99 | 108 | .. | 57 | .. | 72 |

[a] Gain in weight.

concentrations, therefore, was run with some metals to see whether any marked differences would be found.

This second series of tests was made with aluminum designated as 3S, which contained 1.25 per cent manganese and which met ASTM Specification B 209[5] for alloy M1A. Because of this change in metal, the results in the two series of tests were not strictly comparable. In spite of this, the results in most cases led to the same conclusions.

The attack at lower concentrations (0.06 per cent each) of the Nacconol and the polyphosphates was not so great as at higher concentrations (see Table III and Fig. 3). Again the addition of even small amounts of the three most siliceous silicates prevented this corrosion. A small amount of metasilicate (0.012 per cent) increased the attack, but with as much metasilicate as phosphate, corrosion was prevented. Sesquisilicate increased the attack at any concentration.

It is evident that the three siliceous silicates are good inhibitors of the corrosion of aluminum. The metasilicate is good only at concentrations equal to or higher than that of the complex phosphate. The sesquisilicate does not act as an inhibitor at the concentrations tested.

*Zinc:*

The situation with zinc is much more complicated. Even in water, 99.5 per cent zinc is somewhat attacked under the conditions of the tests. The addition of 0.2 per cent of alkyl-aryl sulfonate with its attendant sodium sulfate increased the attack so that there was a loss of 31 mg per sq dm (Fig. 4). When small amounts of the various silicates were added, the loss in weight was cut to approximately half that caused by the detergent alone. However, these silicate additions increased the white deposits on the surface of the zinc which had to be removed in order to determine total corrosion. In Fig. 4 the top disk of each pair shows the deposit except for what dropped off, while the bottom disk has been cleaned by polishing under conditions which caused no measurable loss of weight of untreated zinc disks. The addition of still more silicate, particularly of the more alkaline ones, gave a further reduction in the corrosion of zinc. The results are given in Table IV.

The polishing method of removing the corrosion products was adopted after an attempt to use the chemical method recommended by ASTM Committee D 12 on Soaps and Other Detergents, in procedure B 185,[6] had proved

[6] Tentative Method of Total Immersion Corrosion Test of Non-Ferrous Metals (Appendix II) (B 185 – 43 T), 1952 Book of ASTM Standards, Part 2, p. 1045.

to be too corrosive. In testing this procedure zinc disks, on which there were deposits, were immersed in warm ammonium chloride solution for 15 min, rinsed, dried, and weighed; then immersed in chromic acid solution for 1 min, rinsed, dried, and weighed. The treatment with ammonium chloride was then repeated. The average weight losses were:

| *First $NH_4Cl$ Treatment* | *Chromic Acid Treatment* | *Second $NH_4Cl$ Treatment* |
|---|---|---|
| 4.1 mg | 0.5 mg | 1.2 mg |

These losses seemed excessive so fresh untreated zinc disks were given the same treatment. The losses were:

| *First $NH_4Cl$ Treatment* | *Chromic Acid Treatment* | *Second $NH_4Cl$ Treatment* |
|---|---|---|
| 2.3 mg | 0.4 mg | 0.7 mg |

Since this treatment caused as great or greater corrosion than the detergent solutions, it was abandoned.

The deposit was removed by scrubbing under warm running water with a hand brush. With Nacconol and no phosphate, this was not sufficient. In these cases the disks were scoured lightly for 15 to 30 sec with water and Old Dutch Cleanser. Fresh disks given these treatments showed no loss in weight.

The addition of tripolyphosphate to the alkyl-aryl sulfonate practically doubled the corrosion (Fig. 5). No deposit formed, but the entire surface of the metal was etched. The addition of the silicates reduced the corrosion. This effect was more marked with the more alkaline silicates as is shown in Table V.

Pyrophosphate (Fig 6) increased corrosion to about the same degree as the tripolyphosphate, but the silicates were less effective in reducing corrosion in this case. Larger amounts did give marked reductions as is shown in Table VI. Again the more alkaline silicates were more effective.

At lower concentrations (Fig. 7), the attack by mixtures of synthetic detergent and polyphosphate was almost as great as at the higher ones (Table VII). The addition of silicates, in amounts approximately equal to those now used in household detergents, gave very little effect, but there was a marked reduction in most cases when the concentration of silicate was equal to that of the phosphate.

*Copper:*

In water, in a 0.2 per cent Nacconol solution, and in the latter plus various amounts of the different silicates up to 0.2 per cent, there was practically no weight loss and very little change in appearance. When tripolyphosphate was added to the detergent solution, there appeared to be slight attack. Most of these mixtures gave a loss in weight. The amounts were so small, however, that it did not seem likely that any real damage would be done. The addition of pyrophosphate to a Nacconol solution gave a distinct, but still small, loss in weight, which was reduced by the addition of various silicates. It is not felt that the effect of any of the washing solutions on the copper was sufficient to

TABLE IV.—CORROSION OF ZINC BY 0.2 PER CENT NACCONOL HG PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 31 | 17 | .. | 15 | .. |
| RU | 31 | 16 | 18 | 16 | 9 |
| BW | 31 | 15 | 12 | 17 | 11 |
| Metso Granular | 31 | 19 | .. | 9 | .. |
| Metso 99 | 31 | .. | 17 | .. | 1 |

TABLE V.—CORROSION OF ZINC BY 0.2 PER CENT NACCONOL HG PLUS 0.2 PER CENT SODIUM TRIPOLYPHOSPHATE PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 63 | 50 | .. | 21 | .. |
| RU | 63 | 49 | 28 | 21 | 14 |
| BW | 63 | 36 | 27 | 21 | 15 |
| Metso Granular | 63 | .. | 31 | .. | 4 |
| Metso 99 | 63 | 37 | .. | 6 | .. |

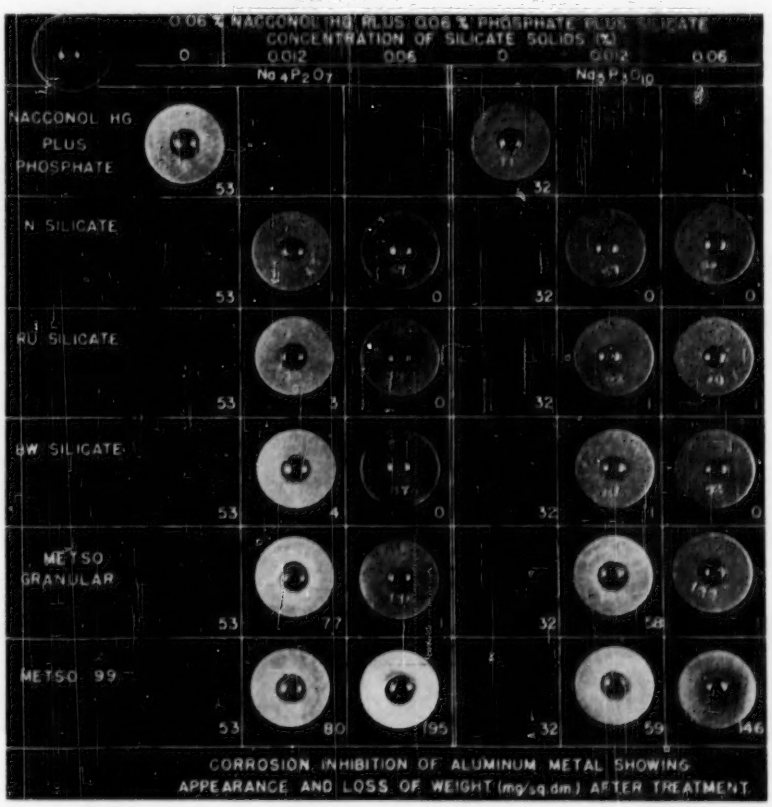



**Fig. 3.—Effect on Aluminum of Detergent Solutions at Indicated Concentrations. Disk in upper left corner is untreated. The figures in the squares with the disks are the weight losses in mg per sq dm. (Etched specimens appear bright because of diffuse reflection.)**

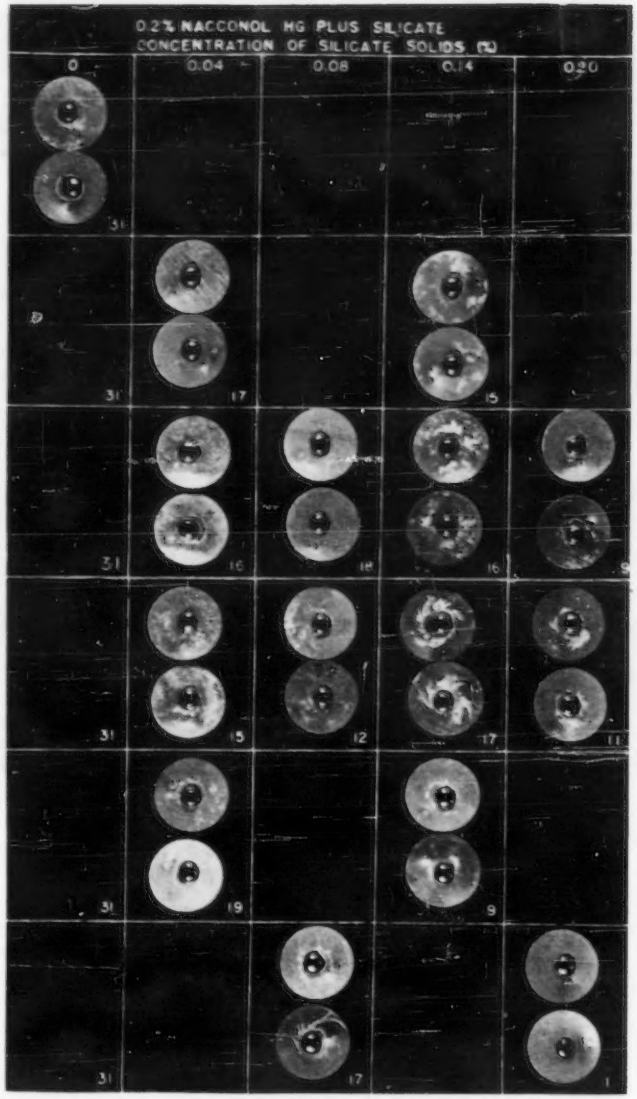



Fig. 4.—Effect on Zinc of 0.2 per cent Solutions of Nacconol HG Alone and with Various Amounts of Silicates.

NOTE.—The figures in the lower right portion of each block represent the loss of weight of the zinc mg per sq dm.

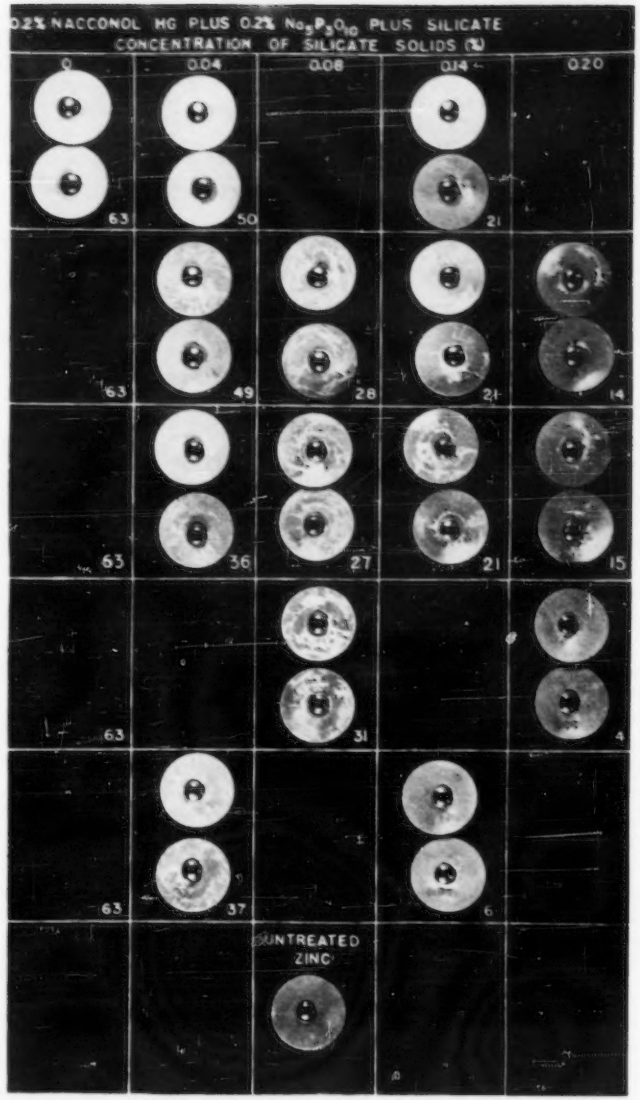



Fig. 5.—Effect on Zinc of Solutions of 0.2 per cent Each Nacconol HG and Sodium Tripolyphosphate with Various Amounts of Silicates.

NOTE.—The figures in the lower right portion of each block represent the loss of weight of the zinc mg per sq dm.

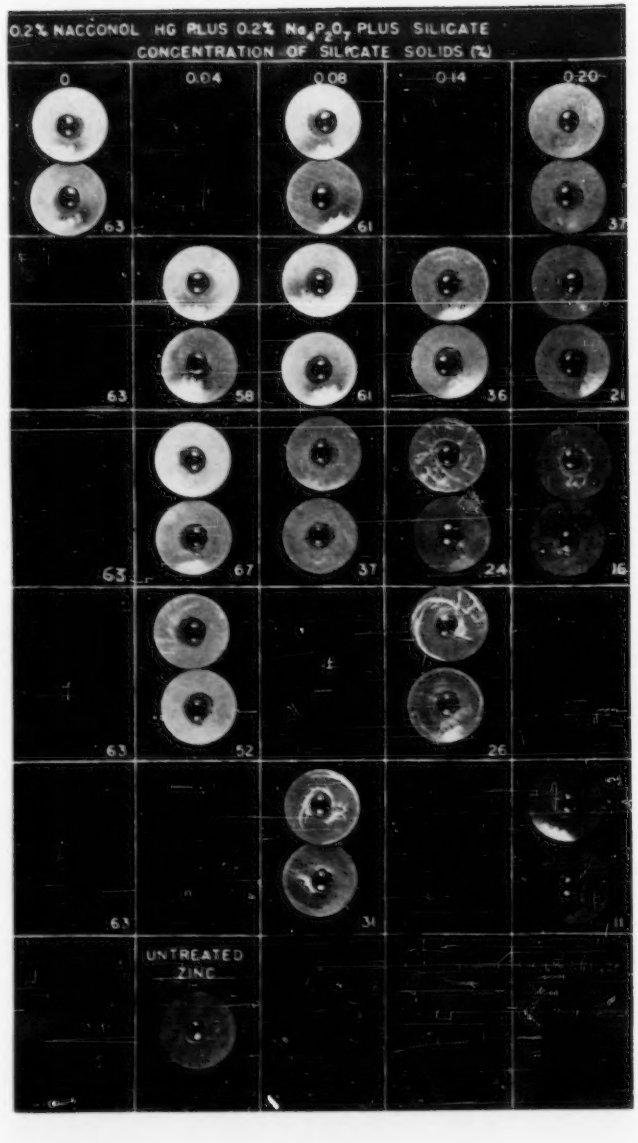



Fig. 6.—Effect on Zinc of Solutions of 0.2 per cent Each Nacconol HG and Tetrasodium Pyrophosphate with Various Amounts of Silicates.

NOTE.—The figures in the lower right portion of each block represent the loss of weight of the zinc mg per sq dm.

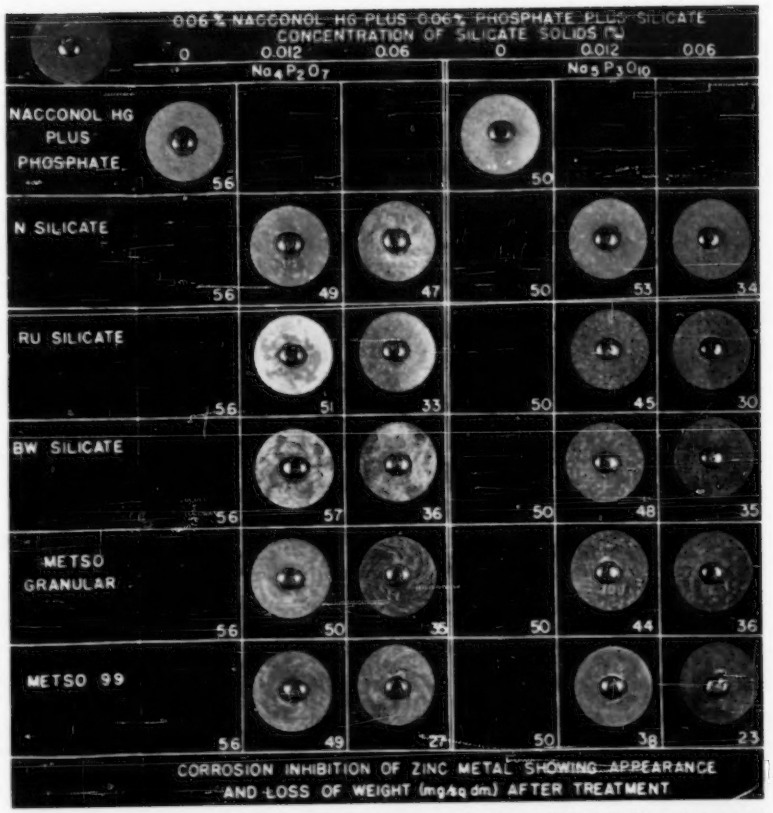



Fig. 7.—Effect on Zinc of Solutions of 0.06 per cent Nacconol HG with Phosphates and Silicates.

TABLE VI.—CORROSION OF ZINC BY 0.2 PER CENT NACCONOL HG PLUS 0.2 PER CENT TETRASODIUM PYROPHOSPHATE PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 63 | .. | 61 | .. | 37 |
| RU | 63 | 58 | 61 | 36 | 21 |
| BW | 63 | 67 | 37 | 24 | 16 |
| Metso Granular | 63 | 52 | .. | 26 | .. |
| Metso 99 | 63 | .. | 31 | .. | 11 |

TABLE VII.—CORROSION OF ZINC BY 0.06 PER CENT NACCONOL HG PLUS 0.06 PER CENT INDICATED POLYPHOSPHATE PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | |
|---|---|---|---|
| | 0 | 0.012 | 0.06 |
| **Tests with 0.06 per cent Sodium Tripolyphosphate** | | | |
| N | 53 | 53 | 34 |
| RU | 53 | 49 | 30 |
| BW | 53 | 48 | 35 |
| Metso Granular | 53 | 44 | 36 |
| Metso 99 | 53 | 38 | 23 |
| **Tests with 0.06 per cent Tetrasodium Pyrophosphate** | | | |
| N | 55 | 49 | 47 |
| RU | 55 | 49 | 33 |
| BW | 55 | 48 | 36 |
| Metso Granular | 55 | 44 | 35 |
| Metso 99 | 55 | 38 | 27 |

do any real damage. The main difficulty in using copper would appear to be the development of couples with other metals present.

*Brass:*

A 70-30 brass was used in these tests. In the first series of tests at the higher concentration, Nacconol alone caused no weight loss. When various silicates, except metasilicate, were used with this solution, the disk either showed no loss or a slight gain in weight. With metasilicate the loss was within the limit of weighing. The mixture of Nacconol and tripolyphosphate caused a small, but distinct, loss in weight, which was reduced by adding the silicates (Fig. 8). A mixture of Nacconol plus pyrophosphate was very slightly more corrosive. Small amounts of the silicates did little or no good; larger amounts appeared to reduce corrosion (Fig. 9).

While the losses in weight with this alloy were too small to cause any concern, the surface of the brass was stained with the phosphate mixtures to an unsatisfactory extent. This was particularly noticeable in the tests at lower concentrations (Fig. 10). The addition of silicates reduced the staining and eliminated it when sufficient quantities were used. The effect of the silicate additions is greater with tripolyphosphate than with pyrophosphate. With the amounts of silicates such as are now generally used in detergent mixtures, the staining was still fairly severe. From this point of view it would be desirable to increase the amount of silicate used. Samples of the disks are the best way to show these effects.

*Nickel Silver:*

Nickel silver is not used in the manufacture of washing machines so far as is known. However, there have been a number of questions as to whether it stains, apparently in connection with flatware used in restaurants. The alloy used in making this test contained 55 per cent copper, 18 per cent nickel, and 27 per cent zinc. The 0.2 per cent alkyl-aryl sulfonate solution caused a slight but distinct loss in weight, which was reduced or eliminated by adding the various silicates, even in small amounts (Table VIII). The silicates also prevented the formation of a faint yellowish stain which was obtained with the sulfonate alone.

When tripolyphosphate was present, the loss in weight with the sulfonate at this concentration was somewhat greater. When small amounts of the more siliceous silicates were added, this loss increased (Table IX). With the

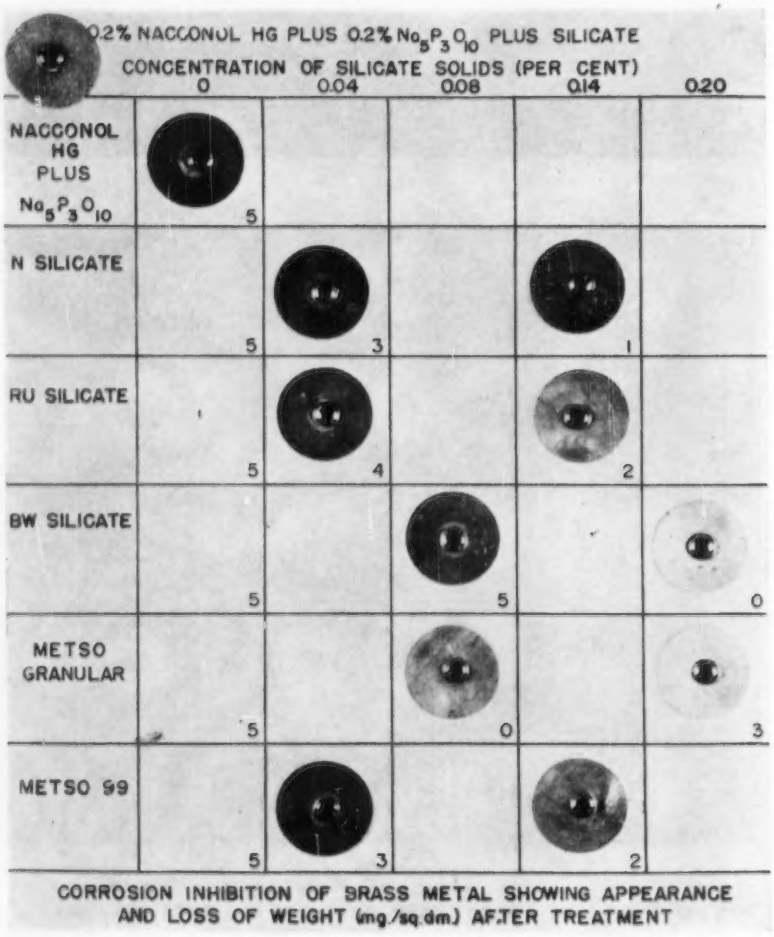



Fig. 8.—Effect on Brass of Solutions of 0.2 per cent Each Nacconol HG and Sodium Tripolyphosphate with Various Amounts of Silicates. (Untreated specimen in upper left corner.)

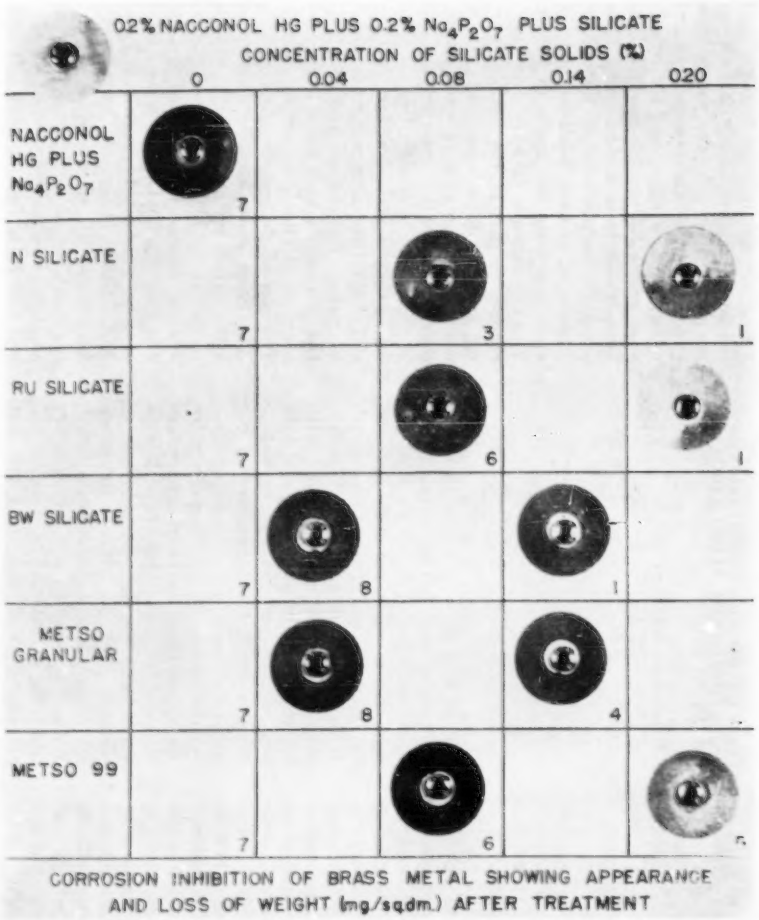



Fig 9.—Effect on Brass of Solutions of 0.2 per cent Each Nacconol HG and Tetrasodium Pyrophosphate with Various Amounts of Silicates.

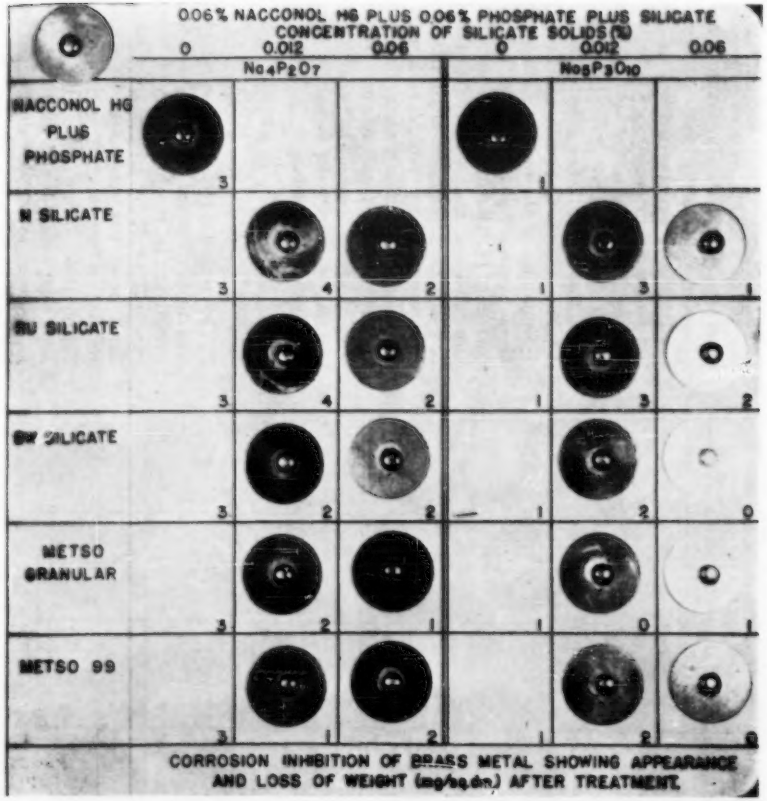



Fig. 10.—Effect on Brass of Solutions of 0.06 per cent Nacconol HG with Phosphates and Silicates. (Infrared photograph by Daniel M. Luehrs in an effort to bring out details of staining. No photograph showed the differences in color and degree of staining.)

TABLE VIII.—CORROSION OF NICKEL SILVER BY 0.2 PER CENT NACCONOL HG PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 3 | 1 | .. | 1 | .. |
| RU | 3 | .. | 0 | .. | 0 |
| BW | 3 | .. | 0 | .. | 0 |
| Metso Granular | 3 | 0 | .. | 0 | .. |
| Metso 99 | 3 | .. | 0 | .. | 1 |

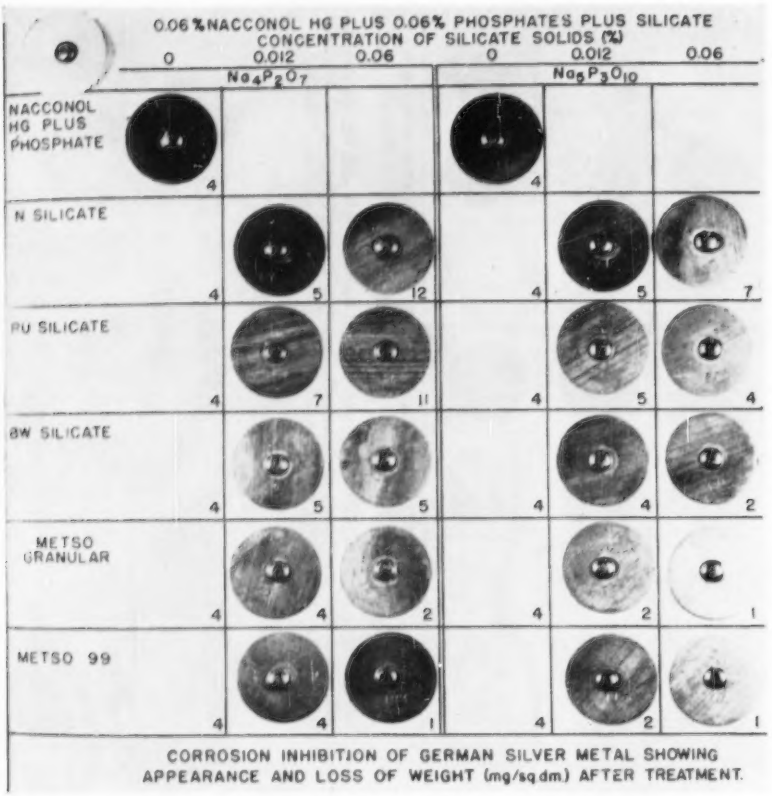



**Fig. 11.—Effect on Nickel Silver of Detergent Solutions.**

TABLE IX.—CORROSION OF NICKEL SILVER BY 0.2 PER CENT NACCONOL HG PLUS 0.2 PER CENT SODIUM TRIPOLYPHOSPHATE PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 6 | 13 | .. | 3 | .. |
| RU | 6 | 10 | 9 | 0 | 0 |
| BW | 6 | 5 | 3 | 0 | 0 |
| Metso Granular | 6 | .. | 2 | .. | 1 |
| Metso 99 | 6 | 1 | .. | 0 | .. |

more alkaline silicates, the loss remained the same or decreased. Larger amounts of all the silicates reduced the amount of corrosion. The outstanding effect of the addition of the silicates was the reduction of staining. The mixture of 0.2 per cent each of tripolyphosphate and sulfonate gave a dark greenish-blue iridescent stain. The addition of even 0.04 per cent of N silicate solids gave a much lighter greenish-yellow stain with slight iridescence. More of this silicate further reduced staining. With the RU silicate solids, which are similar to the silicates now widely used in commercial household detergents, the reduction in staining was even greater. With 0.04 per cent solids of this ratio, a pale greenish-yellow stain occurred, but the metal appeared to be bright. With 0.08 to 0.14 per cent solids, there was only a faint stain, but the metal surfaces were somewhat dull. With 0.20 per cent silicate solids, the metal appeared to be unchanged from the original. With 0.04 to 0.08 per cent BW solids, there was a faint yellow stain. With larger amounts of this silicate and with any quantity of the two crystalline silicates tried, the appearance of the metal was unchanged from the original.

Substitution of pyrophosphate for tripolyphosphate increased corrosion as shown in Table X. It was more difficult to reduce this by the addition of silicates. Actually with N, the corrosion increased within the limits tested. With RU, reduction was only obtained when the silicate solids equalled the phosphate. With BW, 0.14 per cent solids were necessary, but the two crystalline silicates reduced corrosion from the lowest concentration used. However, all the silicate additions tried reduced staining markedly. To get no change in appearance with RU silicate, it was necessary to have the silicate solids equal the phosphate. With the more alkaline silicates, lower concentrations were equally effective.

Some idea of the results obtained at lower concentrations can be gained from Fig. 11. Even this does not give any idea of the colors. At these concentrations only the more alkaline silicates gave any protection against corrosion and then only at the 0.06 per cent level with pyrophosphate. There was, however, considerably reduced staining in every case, especially with the higher silicate solids.

*Enamels:*

The method of testing enamel samples had to be changed as disks were not available. In the first series of tests, panels 77 by 51 by 1.1 mm were used. Each panel was washed under warm running water and dried with a clean cotton cloth before use. The panels were then weighed, and the reflectance and gloss at 45 deg were determined on both sides using a Hunter Multipurpose Reflectometer. Each panel was then immersed in a separate detergent solution at the lower concentration level for 2 hr. Air was bubbled through each solution at approximately 200 cu cm per min. After 2 hr the panels were removed, rinsed under running warm water, dried, weighed, and the reflectance and gloss measurements taken. Since these tests showed very little effect, the samples were run for another 2-hr period in fresh solutions, and the same measurements made as before. This exposure also failed to show much change, so part of the samples were run for 71 hr in fresh solutions. There was some evaporation of water during the first 24 hr of this test which resulted in maximum concentrations slightly higher than those used at first. At the end of this time more water was added to restore the original concentration, and precautions were taken to prevent overconcentration happening again. The over-all changes are given in Table XI. Since these samples showed so little change, the concentration was increased to the higher level used earlier, and the samples were exposed first for 2 hr and then for 17 hr to make a total of 19 hr. The results are given in Table XII. The addition of even small amounts of RU silicate solids reduced the solubility of the enamel, but the addition of Metso 99 increased solution and led to a loss of gloss. It was

TABLE X.—CORROSION OF NICKEL SILVER BY 0.2 PER CENT NACCONOL HG PLUS 0.2 PER CENT TETRASODIUM PYROPHOSPHATE PLUS INDICATED SILICATE IN 2 HR AT 60 C.

| Silicate concentration, per cent | Weight Loss, mg per sq dm | | | | |
|---|---|---|---|---|---|
| | 0 | 0.04 | 0.08 | 0.14 | 0.20 |
| N | 9 | .. | 23 | .. | 14 |
| RU | 9 | 20 | 24 | 16 | 5 |
| BW | 9 | 12 | 14 | 3 | 2 |
| Metso Granular | 9 | 5 | .. | 2 | .. |
| Metso 99 | 9 | .. | 1 | .. | 1 |

TABLE XI.—EFFECT OF DETERGENT SOLUTIONS ON ENAMELS IN 75 HR AT 60 C.

| Sample | Concentration of Detergent Solids, per cent | | | Weight Loss, mg per sq dm | Change in Reflectance[a] | Change in Gloss[a] |
|---|---|---|---|---|---|---|
| | Nacconol HG | Polyphosphate | Silicate | | | |
| No. 7 | 0.06 | 0.06 tripoly | 0 | 4 | +0.6<br>+0.4 | −0.4<br>0.0 |
| No. 8 | 0.06 | 0.06 pyro | 0.01 RU | 2 | −0.8<br>0.0 | −0.1<br>−0.2 |
| No. 10 | 0.06 | 0.06 tripoly | 0.01 RU | 1 | −0.7<br>−1.5 | −0.3<br>0.0 |
| No. 11 | 0.06 | 0.06 tripoly | 0.06 RU | 0 | +0.9<br>+0.5 | −0.2<br>+0.4 |
| No. 20 | 0.06 | 0.06 tripoly | 0.06 Metso 99 | 3 | +0.5<br>+0.4 | −0.2<br>−0.3 |

[a] One figure for each side of the plate.

TABLE XII.—EFFECT OF MORE CONCENTRATED DETERGENT SOLUTIONS ON ENAMELS IN 21 HR AT 60 C.

| Sample | Concentration of Detergent Solids, per cent | | | Weight Loss, mg per sq dm | Change in Reflectance[a] | Change in Gloss[a] |
|---|---|---|---|---|---|---|
| | Nacconol HG | Polyphosphate | Silicate | | | |
| No. 7 | 0.2 | 0.2 tripoly | 0.0 | 3 | +0.2<br>0.0 | −0.5<br>−0.4 |
| No. 8 | 0.2 | 0.2 pyro | 0.04 RU | 1 | −0.2<br>0.0 | −0.1<br>0.0 |
| No. 10 | 0.2 | 0.2 tripoly | 0.04 RU | 0 | +0.1<br>+0.1 | −0.1<br>−0.8 |
| No. 11 | 0.2 | 0.2 tripoly | 0.20 RU | 0 | +0.1<br>+0.1 | −0.4<br>−0.2 |
| No. 12 | 0.2 | 0.2 tripoly | 0.20 Metso 99 | 0 | +1.8<br>+1.6 | −3.5<br>−2.8 |

[a] One figure for each side of the plate.

felt, however, that these tests were conclusive evidence that enamels sufficiently resistant to the action of detergents were available for washing machines. Certainly the resistance of these enamels was very much higher than that of some of the metallic parts which have been used.

However, some samples of experimental enamels were tested. These plates were considerably larger, being 102 by 102 by 1.1 mm. The volume of solution was maintained at a liter per 1.5 sq dm of surface. The exposure time was divided into four periods of 17 hr each. Only three solutions were used; each contained 0.06 per cent of Nacconol HG and of sodium tripolyphosphate. One contained no silicate, one 0.012 per cent RU solids, and one 0.06 per cent of the same silicate. A wider variety of solutions and conditions would have been tried if sufficient enamel samples had been available. The over-all changes are given in Table XIII. Enamels *T* and *Z* were fairly resistant to all three detergent solutions. Both showed some loss in weight and gloss with the solution containing no silicate. These losses were reduced by the inclusion of a small amount of silicate and still further reduced by the larger amount of silicate. Enamel *A* was attacked to a greater extent by the sulfonate and the phosphate, so that the larger amount of silicate was necessary for good protection. Enamel *G*, which was a colored undercoat, was seriously attacked by both the solution without any silicate and that with the small amount of silicate. With the large amount of silicate the attack was not very serious. These results show that it is necessary to choose enamels that are used for washing machines in order to get good resistance, and that, if the enamel is not thoroughly stable, the addition, in increased amounts, of silicate to the detergent solution will help to prevent corrosion.

TABLE XIII.—EFFECT OF DETERGENT SOLUTIONS ON EXPERIMENTAL ENAMELS IN 68 HR AT 60 C.

| Enamel | Weight Loss, mg per sq dm | Change in Reflectance[a] | Change in Gloss[a] |
|---|---|---|---|
| TESTS WITH 0.06 PER CENT NACCONOL HG SOLIDS PLUS 0.06 PER CENT SODIUM TRIPOLYPHOSPHATE | | | |
| *Z* | 13 | +1.3<br>+1.0 | −2.3<br>−2.0 |
| *T* | 16 | −0.1<br>0.0 | −2.1<br>−1.4 |
| *A* | 79 | +1.0<br>+0.7 | −6.3<br>−5.0 |
| *G* | 445 | .. | −1.9<br>−2.6 |
| TESTS WITH SAME SOLUTION PLUS 0.012 PER CENT RU SOLIDS | | | |
| *Z* | 4 | +0.4<br>+0.4 | −0.7<br>−0.6 |
| *T* | 1 | 0.0<br>+0.1 | 0.0<br>0.0 |
| *A* | 42 | +1.7<br>+1.6 | −5.5<br>−4.0 |
| *G* | 102 | .. | −1.1<br>−1.1 |
| TESTS WITH FIRST SOLUTION PLUS 0.06 PER CENT RU SOLIDS | | | |
| *Z* | 2.5 | 0.0<br>+0.1 | −0.3<br>0.0 |
| *T* | 0.6 | −0.1<br>0.0 | +0.1<br>+0.1 |
| *A* | 3 | +0.6<br>+0.6 | −1.1<br>−0.7 |
| *G* | 12 | .. | −0.5<br>−0.6 |

[a] One figure for each side of plate.

## CONCLUSIONS

While the silicate content of the most popular heavy-duty household detergents now on the market is sufficient to prevent the corrosion of aluminum, an increase would be desirable to reduce the corrosion of zinc and its alloys. Increased silicate content would also reduce the staining of brass and nickel silver. Copper is unaffected by detergent solutions under normal washing conditions, but it may cause electrolytic corrosion when used with less resistant metals.

Properly chosen enamels are very resistant to detergent solutions under operating conditions. The silicated detergents lessen any attack and loss of gloss, especially with less resistant enamels.

For use in household detergents, silicates with $Na_2O:SiO_2$ ratios between 1:2.9 and 1:2.5 not only prevent attack on aluminum but reduce attack on zinc and its alloys. This is interesting because these silicates have been found to give slurries with satisfactory viscosities for spray drying.[7]

[7] Raymond Getty and Newton McCready, *Journal*, Am. Oil Chemical Soc., Vol. 30, p. 193–6 (1953).

# Gravitometer for Rapid Density Measurement of Solids

By S. Lipson, A. Saia, and H. Rosenthal

***An apparatus for rapid density measurement of solids consists of a cylinder containing two immiscible liquids, alcohol floating on mercury. Their relative displacements by the sample are the basis for the density determination.***

PREVIOUS work at the Frankford Arsenal has shown that the reduced pressure test can be used in conjunction with density measurements for quantitative determination of gas in aluminum alloy melts. This test is performed by permitting a sample of metal taken from the melt to solidify at reduced pressure. Precipitated gas in the melt occupies a volume which can be related to the solidification pressure in accordance with Boyle's law. If a solidification pressure of 10 cm mercury is used, the volume occupied by the precipitated gas would be multiplied by a factor of 7.6 times the volume occupied when solidification proceeds at atmospheric pressure (76 cm). As a result of this method of solidification, the effect of gas content upon the density of the sample is magnified and, therefore, the presence of gas may be easily detected by density measurement.

In order for this test to be used as a control method in the foundry to check the gas content of aluminum melts before the castings are poured, it is essential that the time required for the density test be kept to a minimum because the waiting time necessary for completion of the test prolongs the length of time in which the melt must be held at temperature. This increases the possibility for change in gas content and develops doubt as to whether the results of the test actually represent the gas content at the time of pouring.

It is apparent from these considerations that the conventional method for density measurement is entirely too time-consuming to be regarded as practical. In order, therefore, to employ the reduced pressure test as a quantitative foundry control test, the time required for density measurement of the sample must be greatly reduced. To satisfy this requirement, an apparatus for rapid density measurements of solids has been developed. The principle of operation and description of this apparatus are discussed in this paper. The apparatus is apparently also promising for application in other fields where rapid density measurements are required.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

## METHODS AND APPARATUS

*Principle of Operation:*

Figure 1 illustrates the principle of operation of this gravitometer showing the containers in which the two immiscible liquids are held. The density of the sample must be intermediate between that of the light and heavy liquids. An example of two such liquids suitable for density determination of aluminum are ethyl alcohol and mercury. The specimen is immersed in the apparatus as shown in Fig. 1. The change in level, $A$, may be accurately determined by means of the inclined arm at the upper end of the apparatus. The specimen finally comes to rest floating upon the surface of the heavy liquid. The level of the heavy liquid changes to correspond with the displacement occurring in this liquid (displacement $B$). This change in level is also indicated by means of an inclined arm at the lower end of the apparatus. The scales on both arms are calibrated to read the volumetric displacement caused by insertion of the specimen. The level changes occurring in these arms can then be used to calculate the density of the sample.

Density is expressed as mass per unit volume:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad \ldots\ldots (1)$$

The change in level in the arms of the instrument may be related to the mass and volume of the specimen as follows:

Volume of specimen = Displacement $A$

Mass of specimen = (Displacement $B$) $\times K$ + (Displacement $A - B$) $\times K_1$

where:

$K$ = density of heavy liquid,
$K_1$ = density of light liquid,
$A$ = volumetric displacement read on scale A, and
$B$ = volumetric displacement read on scale B.

S. LIPSON, metallurgist, Frankford Arsenal, Philadelphia, since 1940, has had his chief metallurgical experience in light alloy foundry research.

ANTHONY SAIA, Metallurgist, Aeronautical Materials Laboratories, Naval Air Experimental Station, Philadelphia Naval Base, is a 1952 graduate of the University of Houston.

H. ROSENTHAL is chief of the foundry division, Pitman-Dunn Laboratories, Frankford Arsenal, which has been improving methods for investment, sand, and shell mold casting of light alloys.

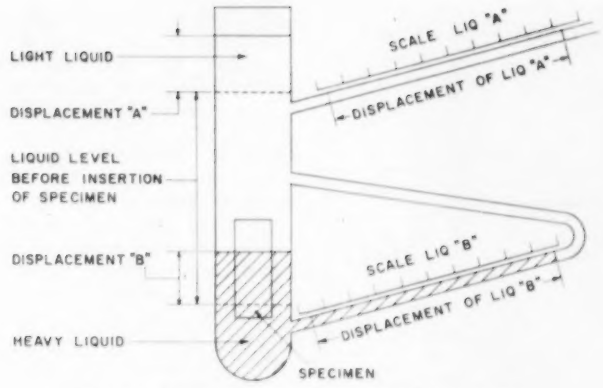



**Fig. 1.—Principle of Operation of the Gravitometer.**

Therefore

$$D = \frac{BK + (A - B)K_1}{A} = \frac{\text{Mass}}{\text{Volume}} \quad \ldots (2)$$

or

$$D = \frac{B(K - K_1)}{A} + K_1 \quad \ldots (3)$$

For a pair of given liquids the expression $(K - K_1)$ may be combined and expressed as $K_0$.

Then

$$D = \frac{BK_0}{A} + K_1 \quad \ldots (4)$$

The density of a specimen may then be obtained by performing the indicated calculation. In the interest of speeding the determination, Eq 4 can be used to design a nomograph so that the arithmetical calculation is avoided.

It is interesting to consider the case of a specimen having a density exactly equal to the density of the light liquid. Under these conditions the specimen may be pictured as being submerged in the light liquid with zero displacement occurring in the lower arm of the instrument. Since $B$ is then equal to zero, the expression $(BK_0)/(A) = 0$, and the density of the sample corresponds to the value of $K_1$ which is the density of the light liquid.

In practice it is desirable to use an arbitrary scale, graduated with linear divisions. This is possible if it is assumed that all the tubes are straight, of constant bore, and that the level of the instrument is not altered in the course of the tests. When a specimen of known density is inserted in the apparatus:

$$K_0 = \frac{K_a l_a}{K_b l_b}(D - K_1) \quad \ldots (5)$$

where:

$K_a$ = volumetric proportionality constant[1] for tube $A$,

$K_b$ = volumetric proportionality constant[1] for tube $B$,

$l_a$ = distance along side arm $A$ indicated by the displacement of the specimen, and

$l_b$ = distance along side arm $B$ indicated by the displacement of the specimen.

Then:

$$\frac{K_b}{K_a} K_0 = \frac{l_a}{l_b}(D - K_1) \quad \ldots (6)$$

$\frac{K_b}{K_a} K_0$ may be combined and expressed as $K_c$:

$$K_c = \frac{l_a}{l_b}(D - K_1) \quad \ldots (7)$$

[1] Volumetric proportionality constant is a constant which, when multiplied by the linear change occurring in a side arm tube, is equal to the total volumetric change. This constant is a function of the bore of the body, the bore of the side arm tube, and the angle which the side arm tube makes with the body.

*Gravitometer:*

Figure 2 is a schematic illustration of the apparatus used for density determination of aluminum alloys. Figure 3 is a photograph of this instrument. The body and arms of the apparatus were fabricated from glass tubing. For the arms, capillary tubing having a bore diameter of 2 mm was used. The bore of the tubing selected for these arms does not affect the sensitivity of the instrument. A relatively narrow bore, however, permits an easily read meniscus to form. The body of the instrument was designed so that the change in level of the heavy liquid occurred in the narrow bore section of the body. This was done so that the linear changes occurring in the two arms when samples of the density range of aluminum alloys were being measured would be of an equal order of magnitude.

For example, consider a 1-in. diameter, 2-in. long aluminum specimen measured in a straight 1.25-in. diameter cylindrical instrument (Fig. 1). Using U. S. P. ethyl alcohol and mercury, an approximate linear change of 180 mm for the upper arm and 30 mm for the lower arm would be indicated. In an instrument designed with a reduced diameter in the lower section (Fig. 2), the linear changes for the same specimen can be adjusted to be of an equal order of magnitude (180 mm) in both arms. This is done by dimensioning the lower cylinder to have a cross-sectional area of approximately one sixth that of the upper cylinder. It is apparent that an error in reading the 30 mm linear change would introduce a far greater percentage error in density measurement than a similar error in reading the 180 mm linear change.

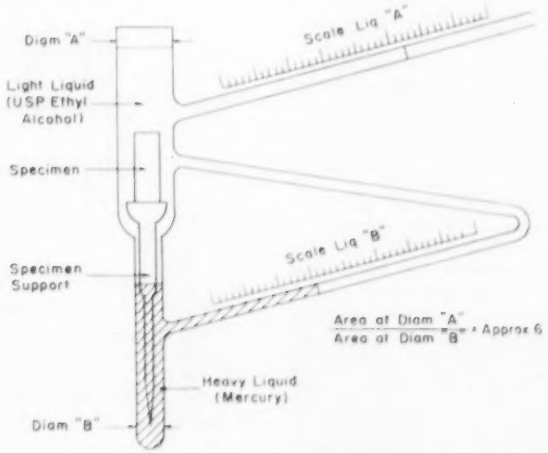



**Fig. 2.—Gravitometer Design for Measuring the Density of Aluminum Specimens Using U. S. P. Ethyl Alcohol and Mercury as Liquids.**

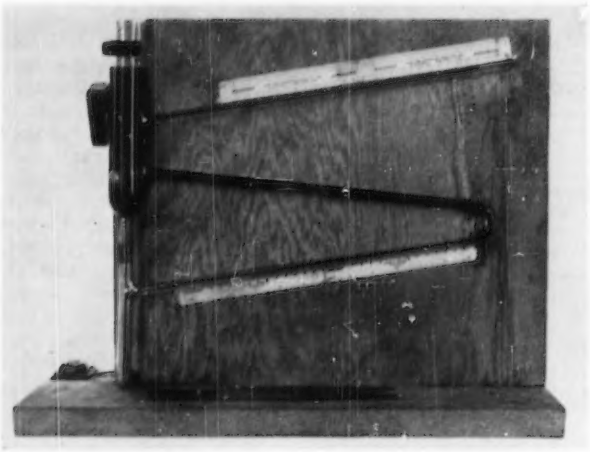


Fig. 3.—Gravitometer Showing Specimen Immersed in Liquid.

This same effect can be produced by altering the angle of the inclined arm at the lower position (Fig. 1) so that the value of the cotangent of its angle with the horizontal is approximately six times as great as the cotangent of the angle formed by the upper arm. This latter solution, however, is not as satisfactory in practice as the one employed in the instrument shown in Fig. 2.

The instrument shown in Fig. 3 was designed to accommodate a 1-in. diameter specimen. The specimen supporter is made of glass and weighted so that it will not float in the light liquid. The supporter has three advantages:

1. It avoids contact of the specimen with the mercury in which surface to surface contact is generally difficult because of the high surface tension of mercury.
2. The specimen does not have to be small enough to enter the mercury tube.
3. The specimen is easily accessible for entry and removal from the apparatus.

It was necessary to install a low energy vibrator to overcome whatever frictional forces may prevent equilibrium floating conditions. A signal buzzer was successfully used for this purpose.

It can be proved that the presence of the pedestal does not affect the density measurement of a specimen.

Tests to determine the reproducibility of this instrument have shown that, in the course of ten successive readings of a given aluminum specimen, the maximum variation of readings will be less than ±0.02 g per cu cm. The current application for the instrument does not demand a greater degree of accuracy than would be obtained with a single reading. If, however, greater accuracy would be required, the average of five or ten readings would increase the accuracy considerably.

## Discussion

It is likely that the reproducibility of the instrument can be significantly improved over the ±0.02 g per cu cm observed in the course of this work. The instrument used for this work is a laboratory constructed model designed primarily to test its application for rapid density measurement of aluminum samples. Reproducibility could no doubt be improved through refinements in construction such as could be effected by a commercial instrument manufacturer. These refinements would include closer fits between the specimen support and the glass tubes, greater uniformity in tubing diameters, and more easily read scales. While the instrument is sufficiently sensitive for the intended application, it is noted that the proposed refinements may be necessary for those density measuring applications where greater sensitivity is demanded.

The effect of room temperature changes on the density readings obtained was considered. An error due to temperature variations can be related to changes in density of the liquids used in the instrument. Expansion or contraction of the instrument itself would have no effect upon the readings since the ratio of the liquid displacement would not be altered. To calculate the error that would occur through density changes of the liquids, it was assumed that a specimen was available that measured exactly 3.000 g per cu cm at 20 C. It was further assumed that the actual density of the specimen would remain constant over the temperature range between 15 and 30 C.

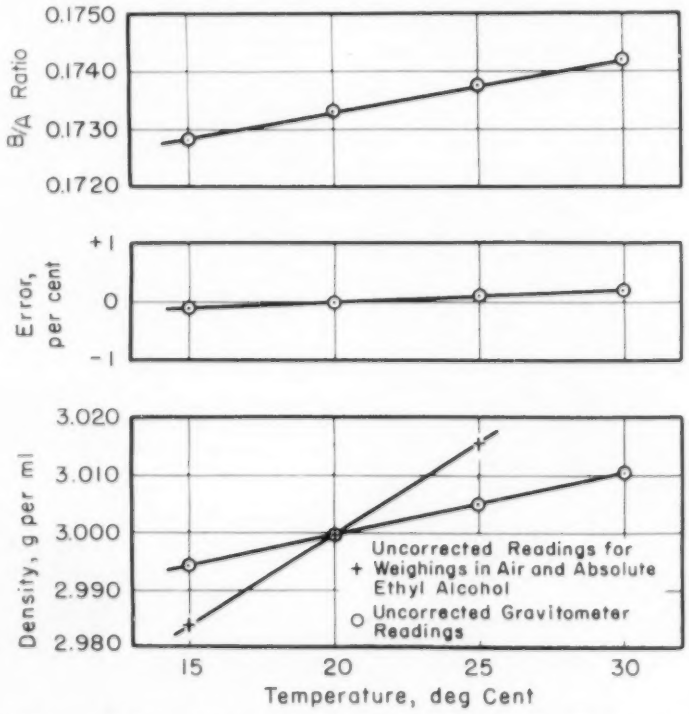



Fig. 4.—Effect of Temperature upon Density Measurements Using Gravitometer and Constant $K_c$ (20 C) over 15 to 30 C Temperature Range.

The ratios $B/A$ were then calculated for this specimen using the values of $K$ and $K_1$ (mercury and absolute ethyl alcohol) for this temperature range. These values were obtained at 5 C increments. This calculation was performed by transposing Eq 3 to obtain the $B/A$ ratio.

$$\frac{B}{A} = \frac{D - K_1}{K - K_1} \quad (8)$$

The values obtained were plotted in Fig. 4 and show how this ratio is affected by temperature variations of the liquids.

The $B/A$ ratio was then used to recalculate the density of the sample over the temperature range using the values of $K$ and $K_1$ for 20 C. This simulates the condition which exists when no correction for temperature is employed. These data are also plotted in Fig. 4. The percentage error due to temperature variation was also calculated and plotted. It may be observed that with the above conditions the error is approximately 0.034 per cent per deg Cent. This error, however, is cancelled somewhat by the thermal expansion occurring in the aluminum. This reduces the net error to 0.027 per cent per deg Cent. If the calibration constant ($K_c$) is calculated for the mean operating temperature (23 C), the maximum error due to temperature variation in the interval 15 to 30 C may be limited to ±0.19 per cent. This error is much smaller than the reproducibility of the instrument ±0.02 g per cu cm (±0.7 per cent) and may be neglected for foundry test purposes. Should an improved model be developed with better reproducibility it would be desirable to compensate for this error.

A similar calculation was performed for the conventional method of weighing in air and liquid (absolute ethyl alcohol). It was found that the error attributable to readings which are uncorrected for temperatures is considerably greater than for the gravitometer method. These data are also shown in Fig. 4.

The gravitometer is now being used to facilitate the study of gas absorption and elimination from aluminum alloy melts. The results of this work will be the subject of another report.

*Acknowledgment:*

The authors are indebted to the Department of the Army for permission to publish this paper. The opinions expressed in the paper are those of the authors and are not necessarily endorsed by the Department of the Army.

# The Yield Rate of Mild Steel

By Frederick Forscher

***New experiments determine dependence of the yield rate on stress and temperature, and results are discussed in terms of nucleation and growth of Lüders' bands.***

The yield point phenomenon of mild steel can roughly be subdivided into three parts, the upper yield point, the drop-off, and the lower yield point, each of which is temperature and strain rate dependent.

The upper yield point represents the load at which the specimen—for a given temperature, strain rate, and geometry—has reached an internal instability condition. It is very sensitive to slight eccentricities of load and may also depend on the surface finish and on the surrounding media. The behavior between the upper and the lower yield point represents a dynamic instability condition, dynamic with respect to both external as well as internal conditions. It is greatly influenced by the stiffness of the loading mechanism. The lower yield point represents the load at which the specimen—for a given temperature and strain rate—is in dynamic equilibrium with the load-applying mechanism. A special case of this equilibrium condition is the static equilibrium.

The lower yield stress, as usually reported, is the stress under which yielding seems to progress more or less uniformly throughout the gage length of the tension test specimen being pulled at a constant rate and under constant temperature; thus it reflects a dynamic equilibrium condition. If the testing machine were stopped, the stress would drop off to its static equilibrium value. This secondary drop-off may be more or less pronounced, depending on the temperature of test and the original rate of deformation.

On the other hand, if the nominal stress at the lower yield point is held constant, as can be done in a creep testing machine, and the temperature is increased, it is found that the yield rate increases. This behavior is expected because the dynamic equilibrium is disturbed and therefore, under the prevailing constant stress, a new dynamic equilibrium rate of deformation must be reached.

This paper describes experiments designed to establish the yield rate of mild steel under various stress and temperature conditions.

*Material and Specimen:*

All test specimens were machined from longitudinal strips taken from the flanges of a wide-flange (16 WF 71) beam of commercial grade (ASTM Specification A 7)[1] semikilled steel and were tested without further treatment. The chemical composition and grain size is given in Table I.

TABLE I.—CHEMICAL COMPOSITION OF HEAT NO. 34 J 333, SEMIKILLED STEEL.

| | |
|---|---|
| Carbon, per cent | 0.21 |
| Manganese, per cent | 0.57 |
| Phosphorus, per cent | 0.021 |
| Sulfur, per cent | 0.031 |
| Silicon, per cent | 0.04 |
| Nickel, per cent | 0.04 |
| Chromium, per cent | 0.06 |
| Molybdenum, per cent | ... |
| Copper, per cent | 0.14 |
| Tin, per cent | 0.01 |
| Nitrogen, per cent | 0.005 |
| Aluminum, per cent | 0.006 |
| ASTM grain size No. 6 | |

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Tentative Specification for Steel for Bridges and Buildings (A 7 – 52 T), 1952 Book of ASTM Standards, Part 1, p. 356.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

*The Author . . .*

**FREDERICK FORSCHER, Westinghouse Electric Corp., Atomic Power Division, Pittsburgh, Pa., since 1952, was for five years an instructor in Civil Engineering at Columbia University teaching mechanics, strength of materials, and materials testing laboratory.**

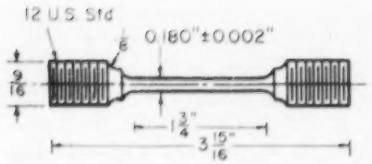
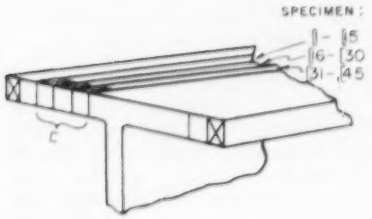



Fig. 1.—Specimen, Type, and Dimensions.




⊠ • Discard

Fig. 2.—Location and Numbering System of Specimens.

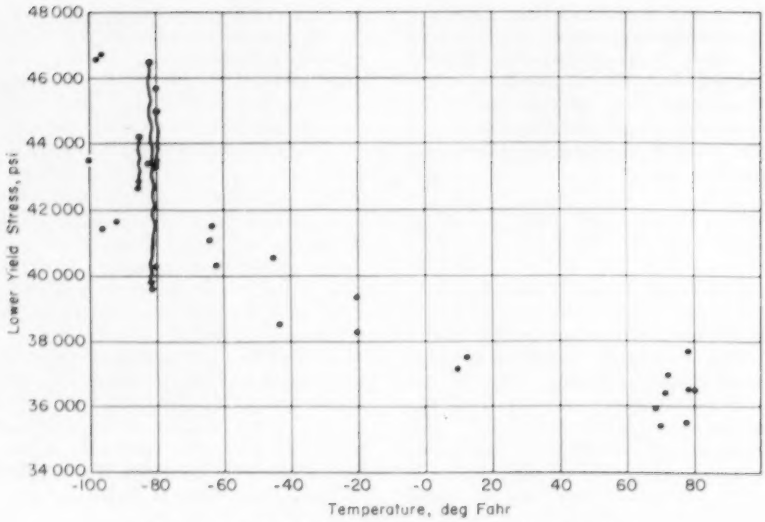



Fig. 3.—Lower Yield Point Stress *versus* Temperature.

The material was chosen to complement a long-range research program on the impact behavior of full-scale (welded and unwelded) beams (1).[2] All testing was performed in the Materials Testing and Research Laboratories of the Civil Engineering Dept., Columbia University, N. Y., in 1952.

The round specimen was of the tension impact type, with dimensions as shown in Fig. 1. The location in the beam and the specimen numbering system are shown in Fig. 2.

Preliminary experiments established the lower yield stress *versus* temperature relation as shown in Fig. 3. The strain rate was kept approximately constant at $4.00 \times 10^{-4} \pm 0.50 \times 10^{-4}$ in. per in. per min up to the yield point and was computed from the recorded load rate. The valve setting for the hydraulic loading mechanism of the testing machine was not changed during any one test until definite indication of work hardening appeared on the load-indicating dial. Under these conditions it was observed that the usual drop-off from the upper to the lower yield stress, at temperatures of about −80 F, was *followed* by a more or less steady further drop-off to a much lower value. This behavior is indicated by a wiggly line in Fig. 3. This secondary drop-off lasted from 1 to 5 min during uninterrupted machine operation.

*Apparatus:*

For subsequent tests a Baldwin screw-type creep testing machine was used (Fig. 4). The furnace unit was removed. This machine autographically records jack motion (*Y*-axis) *versus* time (*X*-axis). The maximum yield rate to which the machine can respond is equal to the maximum rate of jack motion (0.0235 in. per min). The horizontal drive of the recording pen (*X*-axis) was modified to move the pen 1 in. of chart per min.

The load was determined by a dynamometer bar connected by a universal joint to the test specimen. The bar was made of chromium steel with a reduced rectangular cross-section ($A$ = 0.08818 sq in.). For temperature compensation and bending compensation, four SR-4 type A-7 gages were attached to the two flat sides of the bar. These gages formed a four-leg external bridge circuit which was wired to the terminal board of an autographic X-Y (Leeds & Northrup) recorder. The full 10-in. horizontal scale on the chart of the X-Y recorder was adjusted to read 2000 lb.

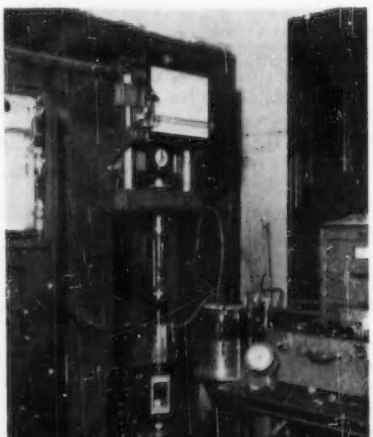


Fig. 4.—Experimental Setup. From left to right: X-Y recorder, screw type creep machine with specimen visible inside the neoprene tube, Dewar liquid nitrogen reservoir, cold junction, thermocouple potentiometer.

*Procedure:*

All tests were performed on as-machined specimens in the following manner. A specimen, surrounded by a neoprene container, in series with a universal joint and the dynamometer bar were assembled in conjunction with appropriate pull rods in the creep machine (Fig. 4). A slight load was applied by hand and noted on the load scale of the X-Y recorder. Then the neoprene container was kept filled with liquid nitrogen, and the load dial on the creep machine was set to approximately the desired stress level; then the jack of the machine started to move to apply this load. This jack motion was not recorded by the autographic recorder. The exact load was read from the X-Y recorder (dynamometer-bar response) and held constant for at least 10 min to allow the temperature (−321 F) to reach equilibrium prior to each test run. A complication arose during this period due to the fact that the progressive cooling of the specimen adapters and pull rods slightly shortened the assembly and thus increased the load. The machine responded by automatic unloading.

During the experiment, however, the machine is expected to load automatically when yielding of the specimen causes the load to drop. To overcome this condition, the two electric make-and-break contacts of the load dial on the creep machine had to be narrowed considerably in order to decrease the "play" between the contact for "load" and the contact for "unload" signals.

When temperature equilibrium was reached, the autographic recorder on the creep machine was started and at time $t = 0$ the liquid nitrogen was removed by lifting the neoprene tube off its base plate. Two typical autographic curves are shown in Figs. 5 and 6. (Figure 7 is the record for a typical room temperature experiment.) Upon the sudden removal of the coolant, the specimen warms up. The theoretical temperature elongation rate is in good agreement with the recorded rate. The theoretical rate of expansion is $\alpha L \times (\Delta T \text{ per min}) = 6.5 \times 10^{-6} (1.75)\ 95 = 0.00108$ in. per min. This rate, of course, is not constant but changes with the rate at which the temperature increases per minute, decreasing as time goes on. During a 15-min temperature warm-up for a specimen subjected to 1000 psi stress, the experimental rate was found to vary between 0.0005 and 0.0015 in. per min. Even in the first minute of warm-up in which the temperature change is the fastest, the temperature elongation rate is only a small portion of the total elongation rate (see Fig. 5). The reported maximum and minimum yield rate values were determined from the slope of tangents to the recorded curve. The slope was measured, not with respect to the $X$-axis, but with respect to a constant temperature elongation rate (assumed at 0.0010 in. per min). Thus, the yield rate of the specimen, as reported, is independent of the change in length due to temperature but is merely a function of the stress and the instantaneous temperature. The latter is determined from the abscissa (time axis) of the point of tangency and a time-temperature calibration curve. As a check, two specimens were run at the same stress level. This resulted in practically identical curves.

The result for the lowest practical stress level (41,500 psi) is shown in Fig. 6. At still lower stress levels the yield rate becomes too nearly equal to the temperature elongation rate and the time of yield becomes indistinct. The highest practical stress level (56,000 psi) is reached when the maximum yield rate is nearly the maximum rate of the jack motion of the creep machine (0.0235 in. per min).

The yield rates were calculated from ten such curves, as shown in Figs. 5, 6,

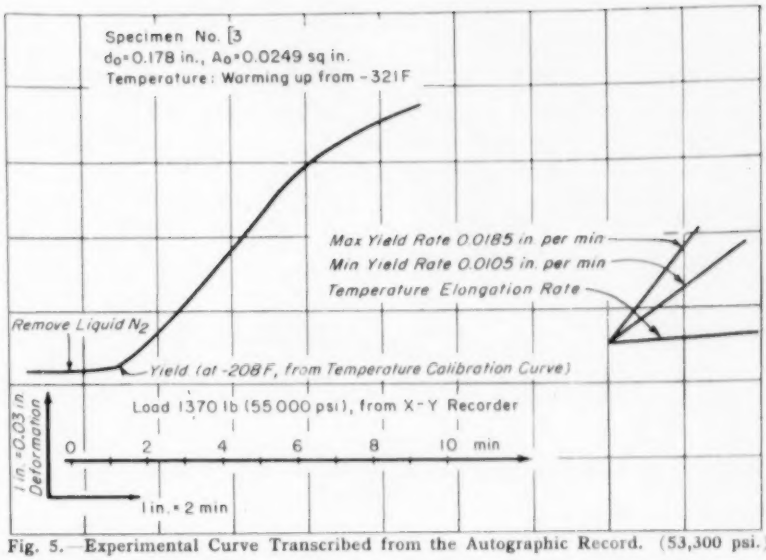

Specimen No. 3
$d_o$ = 0.178 in., $A_o$ = 0.0249 sq in.
Temperature: Warming up from −321F
Max Yield Rate 0.0185 in. per min
Min Yield Rate 0.0105 in. per min
Temperature Elongation Rate
Remove Liquid $N_2$
Yield (at −208F, from Temperature Calibration Curve)
Load 1370 lb (55 000 psi), from X-Y Recorder
1 in. = 0.03 in. Deformation
0 2 4 6 8 10 min
1 in. = 2 min

Fig. 5.—Experimental Curve Transcribed from the Autographic Record. (53,300 psi.)

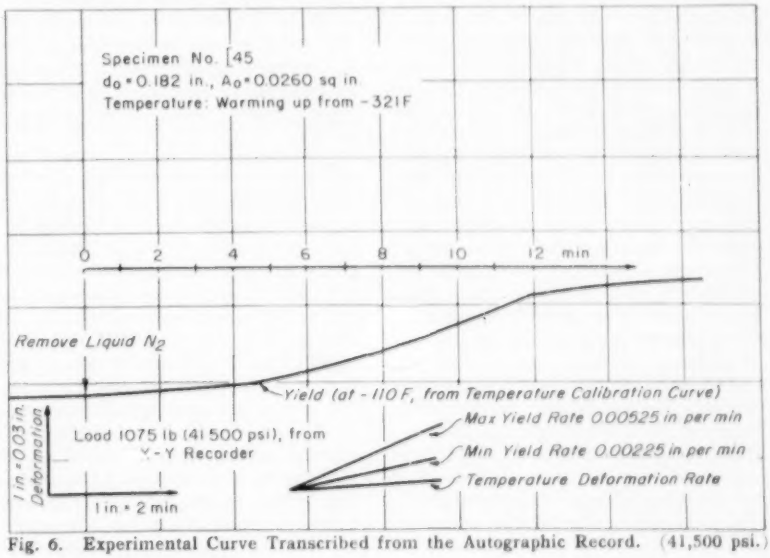

Specimen No. 45
$d_o$ = 0.182 in., $A_o$ = 0.0260 sq in.
Temperature: Warming up from −321F
0 2 4 6 8 10 12 min
Remove Liquid $N_2$
Yield (at −110F, from Temperature Calibration Curve)
Max Yield Rate 0.00525 in per min
Min Yield Rate 0.00225 in per min
Temperature Deformation Rate
Load 1075 lb (41 500 psi), from X-Y Recorder
1 in. = 0.03 in. Deformation
1 in. = 2 min

Fig. 6. Experimental Curve Transcribed from the Autographic Record. (41,500 psi.)

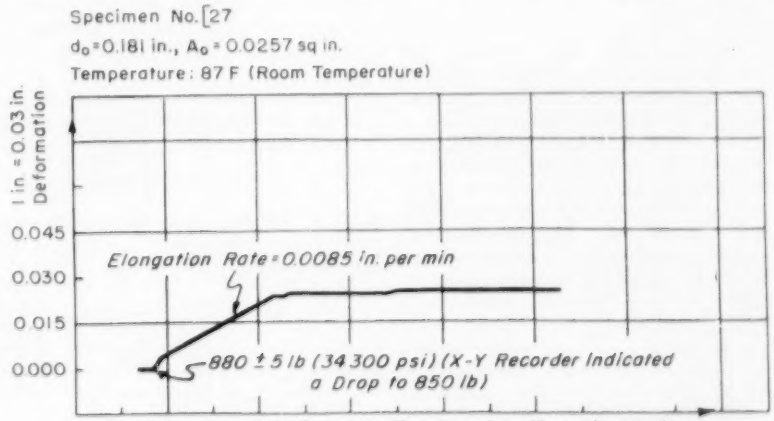

Specimen No. 27
$d_o$ = 0.181 in., $A_o$ = 0.0257 sq in.
Temperature: 87 F (Room Temperature)
1 in. = 0.03 in. Deformation
0.045
0.030
0.015
0.000
Elongation Rate = 0.0085 in. per min
880 ± 5 lb (34 300 psi) (X-Y Recorder Indicated a Drop to 850 lb)
1 2 3 4 5 6 7 8 9 10 1 in. = 2 min

Fig. 7.—Experimental Curve Transcribed from the Autographic Record. (34,300 psi.) Room temperature test.

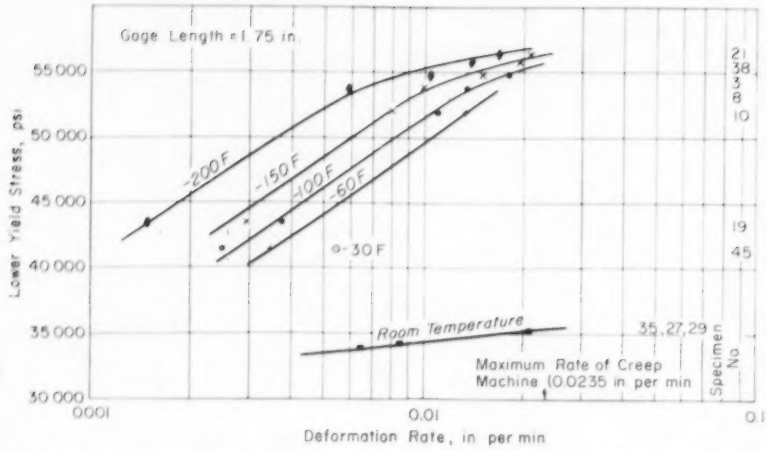



**Fig. 8.—Lower Yield Point Stress *versus* Logarithm of Deformation Rate for Different Test Temperatures.**

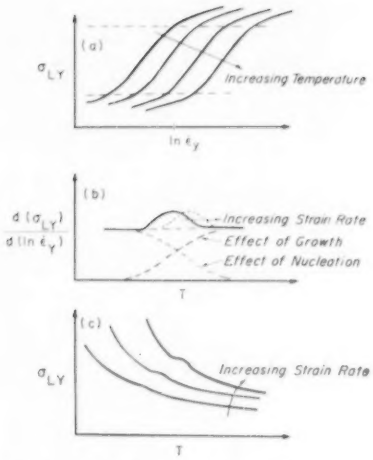



**Fig. 9.—Schematic Relationships. $\sigma_{LY}$ = lower yield point stress, $\dot{\epsilon}$ = yield rate, $T$ = temperature.**

and 7. The results are shown in Table II and plotted in Fig. 8. Points of equal temperature are connected mainly by straight lines, though a set of sigmoidal curves would probably be more appropriate (Fig. 9(*a*)). In the present case, it is assumed that a set of straight lines is a good approximation for the range of yield rates investigated. This representation resembles superficially the conventional plot of stress level *versus* the logarithm of the second-stage creep rate. However, the latter is associated with a phenomenological homogeneous process, while the present data represent a distinctiy heterogeneous behavior.

The slope of the room-temperature line is in good agreement with data published by Clark and Wood (**2**). Though their data are scattered in the higher regions of the yield rate, a slope of 3500 psi per cycle of $\log_{10}$ is representative. The present data give 2700 psi per cycle of $\log_{10}$.

*Discussion:*

The results show that the slope of the curves in Fig. 8 for a certain deformation rate first increases and then decreases with decreasing temperature. This is shown schematically in Fig. 9(*b*). It implies that the lower yield stress *versus* temperature curve must have a hump in the region roughly between 42,000 and 55,000 psi. Approximately at stress levels below 42,000 psi, an increase of 2700 psi in lower yield stress per tenfold increase in strain rate is expected; at stress levels between 42,000 and 55,000 psi a 16,000 psi increase per tenfold increase in strain rate is expected (Fig. 9(*c*)). It is suggested that yielding at lower stress levels or higher temperatures proceeds mainly by the mechanism of growth (spreading of one or two Lüders' bands), while at higher levels, or lower temperatures, nucleation predominates. At intermediate stress levels or temperatures, both nucleation of new bands as well as growth can occur. This suggestion is schematically shown in Fig. 9(*b*).

No explicit relationship between sites of nucleation, $N$, and stress level is here proposed. Such a function, $N$ ($\sigma_{LY}$), would be sensitive to the statistical distribution of inhomogeneities and hence to the size of the specimen.

Another experimental indication of this behavior is shown by the data of Fig. 3. The item of interest is the second drop-off, indicated by the wiggly lines in the figure: a relaxation of stress from—what seemed at first—the lower yield stress level. If the rate of the machine motion is just slightly lower than the elongation rate of the specimen due to the spreading of many Lüders' bands, the result will appear as a secondary drop-off. At higher stress levels (lower temperature) multiple working zones form at the upper yield stress. Consequently, the original drop-off is much larger, due to the nucleation, but the rate of growth is decreased because of the lower temperature.

It has been suggested that a unique relationship exists during yielding between strain rate, lower yield stress, and temperature (mechanical equation of state). For rolled ship plate steel, Hollomon (**3**) shows that the logarithm of the lower yield stress *versus* $1/T$ is a straight line. A similar plot for mild steel from data by Davis, Parker, and Boodberg (**4**) does not reveal any linearity. Eldin and Collins' data for 1020 steel (**5**) appears as a straight line on a plot of stress *versus* $1/T$. In the present investigation, the data fall within a *band* of stress *versus* $1/T$. This widening into a band must be expected in view of the fact that the yield rate, as shown, is a pertinent parameter of the state of the system; thus, the lower yield stress at a fixed temperature is a function of the yield rate. The linearity or nonlinearity of the relation depends on the degree of nucleation of working zones associated with the stress level and is affected by the stiffness of the machine. The nucleation in turn may depend on internal distribution of inhomogeneities and perhaps on residual stresses.

TABLE II.—YIELD RATES AT DIFFERENT TEMPERATURES AT CONSTANT NOMINAL STRESS.

| Specimen | Nominal Stress, psi | Yield Rates at Indicated Temperatures, in. per min | | | | |
|---|---|---|---|---|---|---|
| | | At −200 F | At −150 F | At −100 F | At −60 F | Others |
| No. 21 | 56 500 | 0.0170 | 0.0210 | ... | ... | ... |
| No. 38 | 56 000 | 0.0140 | 0.0195 | ... | ... | ... |
| No. 3 | 55 000 | 0.0105 | 0.0150 | 0.0180 | ... | ... |
| No. 8 | 54 000 | 0.0060 | 0.0100 | 0.0135 | ... | ... |
| No. 10 | 52 200 | ... | 0.0080 | 0.0110 | 0.0135 | ... |
| No. 19 | 43 500 | 0.0015 | 0.0030 | 0.0038 | ... | ... |
| No. 45 | 41 500 | ... | ... | 0.0025 | 0.0035 | 0.0055 (at −30 F) |
| No. 29 | 35 400 | ... | ... | ... | ... | 0.0210 (at −84 F) |
| No. 27 | 34 300 | ... | ... | ... | ... | 0.0085 (at −87 F) |
| No. 35 | 34 000 | ... | ... | ... | ... | 0.0065 (at −78 F) |

*Acknowledgments:*

The author wishes to express his appreciation to W. J. Krefeld, Director of the Materials Research and Testing Laboratories of the Civil Engineering Department, Columbia University, for the use of the facilities and material, and to A. M. Freudenthal and M. Gensamer for stimulating discussion and advice.

REFERENCES

(1) W. J. Krefeld and B. G. Anderson, "Transition Temperatures of Structural Steel Beams with Butt-Welded Splices," *The Welding Journal*, Vol. 32, Nov., 1953.

(2) D. S. Clark and D. S. Wood, "The Time Delay for the Initiation of Plastic Deformation at Rapidly Applied Constant Stress," *Proceedings*, Am. Soc. Testing Mats., Vol. 49, p. 717 (1949).

(3) J. H. Hollomon, "The Problem of Fracture," A Report of the Welding Research Council, American Welding Society (1946).

(4) H. E. Davis, E. R. Parker, and A. Boodberg, "A Study of the Transition from Shear to Cleavage Fracture in Mild Steel," *Proceedings*, Am. Soc. Testing Mats., Vol. 47, p. 483 (1947).

(5) E. S. Eldin and S. C. Collins, "Fracture and Yield Stress of 1020 Steel at Low Temperatures," *Journal of Applied Physics*, Vol. 22, p. 1296 (1951).

# Measuring Volume Shrinkage of Resinous Mortars

By Lloyd H. Brown and E. A. Reineck

***This method which measures total shrinkage of resinous mortars as they pass from the trowelable form to the fully cured state may be useful in predicting the maximum shrinkage of resinous mortars under actual service conditions.***

THE use of resinous mortars, such as the phenolaldehyde type and the furfuryl alcohol type, is based on their ability to pass from the trowelable or plastic form to the solid state without much change in dimensions. They are employed principally in corrosion-resistant construction for the chemical process industry where such materials as steel, alloys, lead, concrete, etc., disintegrate rapidly. Resinous mortars are prepared by mixing an inert filler with a liquid resin. The resin portion of the mortar is converted to the solid and chemically inert stage by acid catalysts previously deposited on the filler.

Since it is observed that mortars shrink under service conditions, it is desirable to measure their shrinkage between the trowelable and the fully cured state. To measure the total shrinkage, we have employed a method based on the specific gravity change and the weight loss of a mortar between the plastic state and the fully cured state, the latter being obtained by heating the mortar to a constant weight at 180 C in a vacuum oven. The value obtained is believed to correspond to the maximum shrinkage of resinous mortars under service conditions and should be a useful tool in evaluating the resinous mortars offered commercially.

## APPARATUS

The apparatus used in this experiment consists of the following:

1. Two 50-ml pycnometers (Fig. 1). It is suggested that specific gravity bottles similar to those described in ASTM Methods D 153[1] be used. They should be custom modified to 19/22 standard taper ground glass joint at the neck to facilitate the introduction of plastic mortar into the bottle. (The authors had the standard taper 10/18 neck replaced with a standard taper 19/22 neck; then, a bushing adapter standard taper 19/22 to 10/18 was added to accommodate the regular 10/18 thermometer.) Kerosine is used as the medium to measure specific gravity. Since kerosine changes appreciably in specific gravity with small change in temperature, it is necessary to use pycnometers having thermometers to fit ground glass joints. Kerosine is selected, as the mortars even in the plastic state are insoluble in it, and there is less trouble with air bubbles adhering to the mortar as is the case when water is the medium.
2. Vacuum oven capable of 29-in. vacuum at 180 C.
3. Wiley mill or small hammer mill.

## PROCEDURE

Statistical procedure is used to achieve representative sampling. Spread 150 g of mortar (mixed in the recommended resin-filler ratio) on a glass plate to a thickness of about $\frac{1}{4}$ in. and score into $\frac{1}{4}$-in. squares. Alternate cubes, roughly $\frac{1}{4}$ by $\frac{1}{4}$ by $\frac{1}{4}$-in., are then arranged into three groups, *A*, *B*, and *C*.

One group of cubes, *A*, is divided into two parts, each weighing about 25 g;

L. H. BROWN, Group Leader in Use Research, Chemicals Department, The Quaker Oats Co., since 1949, is the author of six papers and five patents in the field of condensation polymers.

E. A. REINECK, in charge of Use Research as Assistant Sales Manager, Chemicals Department, The Quaker Oats Co., since 1951, is currently Secretary of ASTM Committee C-3 on Chemical-Resistant Mortars.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Tentative Methods of Test for Specific Gravity of Pigments (D 153 - 52 T), 1952 Book of ASTM Standards, Part 4, p. 196.

each part is checked for initial specific gravity. Mortars *B* and *C* are placed in two petri dishes, weighed, and placed in a forced air circulating oven overnight at 50 C to determine the initial weight loss.

About half of the hardened mortar in each petri dish, approximately 50 g, is ground to a powder in a small hammer mill. It is advisable to use a magnet to remove possible iron contamination after each grinding step. The powder is then placed in two petri dishes, weighed, and heated at 180 C to a constant weight in a vacuum oven at a 29-in. vacuum, thus obtaining the final weight loss.

The other half of the hardened mortar, about 50 g, is broken into lumps to fit into the pycnometers, and about 25 g is placed into each to determine the specific gravity of the lumps of set mortar. Then the material is removed from the pycnometer, washed with petroleum ether to remove the kerosine, dried, and ground to a powder in the hammer mill. The specific gravity of powdered set mortar is again checked in the pycnometers. The difference in the specific gravity of the lump and the powdered mortar is due to voids in the plastic mortar. The per cent of voids based on the specific gravity of set mortar (lump) is calculated and multiplied by the initial specific gravity of the plastic mortar; this yields a value which is added to the initial specific gravity of the plastic mortar to give the adjusted initial specific gravity. Special precautions are necessary to remove air bubbles. The samples are stirred in the pycnometers and a good vacuum is applied to remove the last of the air bubbles.

When the material in the vacuum oven has reached a constant weight (this will take 2 to 4 days with properly catalyzed resin mortar and considerably longer for under-catalyzed systems), the final weight loss and the specific gravity of the powder are determined. The volume shrinkage is calculated from the adjusted initial specific gravity, the final specific gravity, and the adjusted over-all weight loss.

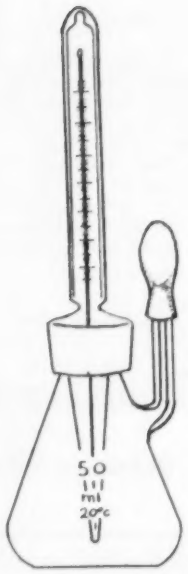



Fig. 1.—A 50-ml Pycnometer.

### Calculation of Volume Shrinkage

The percentage of volume shrinkage is calculated as follows:

Initial volume in cu cm per g = 1.000 divided by the adjusted initial specific gravity.

Final volume in cu cm per g = 1.000 minus the adjusted over-all weight loss divided by the final specific gravity.

Shrinkage in cu cm per g = initial volume minus the final volume.

Per cent shrinkage = shrinkage divided by initial volume.

*Example.*—Using mortar No. 1, Table I:

$$\text{Initial volume} = \frac{1}{1.6414} = 0.609$$

$$\text{Final volume} = \frac{1 - 0.0515}{1.7541} = \frac{0.9485}{1.7541} = 0.541$$

$$\text{Shrinkage} = 0.609 - 0.541 = 0.068$$

$$\text{Per cent shrinkage} = \frac{0.068}{0.609} = 11.20 \text{ per cent}$$

### Calculation of Adjusted Over-all Weight Loss

Since the initial weight loss, $I$, is based on the plastic mortar and the final weight loss, $F$, is based on the set and powdered mortar, it is necessary to make a calculation on the final weight loss in order to base it on the plastic mortar before determining the adjusted over-all weight loss. This adjustment is made by multiplying the final weight loss, $F$, by $[1 - (I/100)]$.

*Example.*—Using mortar No. 1, Table I:

Initial weight loss based on plastic mortar = 0.955 per cent

Final weight loss based on plastic mortar = $(4.234) \times (1 - 0.0095) = 4.194$ per cent

Adjusted over-all weight loss based on plastic mortar = 4.194 + 0.955 + 5.149 per cent

*Typical Data Obtained by the Method:*

Mortars Nos. 1 and 2 in Table I were prepared from commercial resins and fillers, and No. 3 represents a mortar from an experimental resin and filler. In each of the three mortars, the viscosity of the resin was 200 centipoises at 25 C, and one part, by weight, of resin was mixed with two parts of catalyzed filler.

TABLE I.—TYPICAL DATA OBTAINED IN MEASURING VOLUME SHRINKAGE OF RESINOUS MORTARS.

| Resinous Mortar | Initial Specific Gravity of Plastic Mortar | Specific Gravity of Set Mortar (Lump) | Specific Gravity of Set Mortar (Powder) | Specific Gravity of Mortar at Constant Weight (Powder) | Adjusted Initial Specific Gravity of Plastic Mortar | Initial Weight Loss Based on Plastic Mortar, per cent | Final Weight Loss Based on Set Mortar, per cent | Adjusted Over-all Weight Loss Based on Plastic Mortar, per cent | Volume Shrinkage, per cent |
|---|---|---|---|---|---|---|---|---|---|
| No. 1 | | | | | | | | | |
| 1 | 1.5951 | 1.6522 | 1.6965 | 1.7514 | | 0.877 | 4.179 | | |
| 2 | 1.6015 | 1.6532 | 1.6996 | 1.7567 | | 1.033 | 4.289 | | |
| Average | 1.5983 | 1.6527 | 1.6981 | 1.7541 | 1.6414 | 0.955 | 4.234 | 5.149 | 11.2 |
| No. 2 | | | | | | | | | |
| 1 | 1.5940 | 1.6327 | 1.7066 | 1.7540 | | 0.884 | 3.265 | | |
| 2 | 1.5917 | 1.6221 | 1.7052 | 1.7563 | | 0.794 | 3.181 | | |
| Average | 1.5928 | 1.6274 | 1.7054 | 1.7552 | 1.6691 | 0.839 | 3.223 | 4.035 | 8.8 |
| No. 3 | | | | | | | | | |
| 1 | 1.5999 | 1.6168 | 1.6835 | 1.7091 | | 0.374 | 2.553 | | |
| 2 | 1.6011 | 1.6156 | 1.6880 | 1.7075 | | 0.314 | 2.529 | | |
| Average | 1.6005 | 1.6162 | 1.6858 | 1.7083 | 1.6695 | 0.344 | 2.541 | 2.876 | 5.1 |

# The Bookshelf

## Titanium and Titanium Alloys

**John L. Everhart, Reinhold Publishing Corp., 330 W. 42nd St., N. Y., 180 pp., $3.**

TITANIUM, often called the "wonder metal," has received considerable publicity in the past several years.

Much of the available data have been sifted and the results included in this pocket-size book, the first in a series to be known as the Reinhold Pilot Books.

The 180 pages are divided into 10 chapters, a one-page appendix, and a quite helpful index.

Starting with the occurrence, extraction, and production from the basic rutile ($TiO_2$) or ilmanite ($FeTiO_3$), the book discusses high-purity titanium, commercial titanium, and titanium alloys. Individual chapters are devoted to heat treatment, fabricating machining, and finishing. The problem of joining, which is a difficult one, is treated separately, and finally there is some discussion of the applications of this metal and its alloys. A number of tables and figures are included.

• • •

## Retailers Plastics Manual

THIS publication is part of the plastics industry's program to give retailers and consumers authoritative information on which to base purchases, sales, and proper use of plastics. It includes practical information on twelve major plastics, emphasizing three elements essential to correct buying and successful use of plastics products: the individual qualities of each plastic, how to care for, and how to clean it. In line with the industry's effort to promote proper use of plastics, the manual includes both advantages and limitations of each material.

To point up the significance of individual plastics qualities, the book cites representative retail products that depend on specific qualities for their successful performance.

At the suggestion of retail executives, the facts on each material are presented in concise, easy-to-remember phrases. The intent was to provide buyers with a quick, authoritative, down-to-earth reference book; and to give sales personnel the answers to customer questions on performance, use, and care of plastics.

To give the retailer a clearer understanding of the complex family of plastics materials, the manual includes a brief description of how plastics products are made and a summary of the qualities and sales features common to plastics.

The manual outlines a sales training program for retail stores and gives specific suggestions for product demonstrations.

Selling aids provided by the plastics industry are discussed, including Quality Standards and Seals of Quality, Informative Labeling, and a program of Retailer-Consumer information.

The booklet incorporates a glossary of trade terms and an 8-page directory of plastics trade names.

Limited quantities of the booklet are available to those directly concerned with plastics merchandising, without charge; to others in any quantity at 50 cents per copy. It may be obtained from The Society of the Plastics Industry, Inc., 67 W. 44th St., New York 36.

• • •

## Standard Samples and Reference Standards

**National Bureau of Standards, Circular 552, Government Printing Office, Washington 25, D. C., 23 pp., 25 cents**

THIS Circular contains a descriptive listing of the various Standard Samples issued by the National Bureau of Standards. A schedule of weights and fees, as well as direction for ordering, is included. Summarized tables of analyses are presented, to indicate the type of standards of composition presently available. The current status of the various standards will be indicated by a mimeographed insert.

The NBS program on standard samples has been in existence almost since the organization of the Bureau. The first standards were prepared in 1905, and today over 500 different standard samples of chemicals, ores, ceramics, and metals are prepared, certified, and distributed by NBS. They are sent to analytical and research laboratories for use in controlling chemical processes and in maintaining the accuracy of apparatus and equipment. The standard samples are materials that have been carefully analyzed, or whose physical properties have been precisely determined, at the Bureau and other laboratories.

## Thermal Conductivity of Metals and Alloys at Low Temperatures

**R. L. Powell and W. A. Blanpied, NBS *Circular* 556, Government Printing Office, Washington 25, D. C. 68 pp., 50 cents.**

ACCURATE data on the thermal conductivity of construction materials at low temperatures are essential in the design of cryogenic equipment. Such data on pure metals also have important applications in basic physics.

The present *Circular* was prepared by the NBS-AEC Cryogenics Laboratory of the NBS Boulder Laboratories to satisfy the need for a complete and authoritative compilation of the useful but widely scattered data on thermal conductivity at low temperatures. It includes tables of measured values of thermal conductivity for metals and alloys from room temperature down to approximately 0 K. The more extensive and important data are plotted in 48 graphs. The data are essentially complete for literature reference from 1900 to early 1954. For comparison, several graphs and tables are given for some representative dielectrics.

• • •

## Forest Products Research Society Proceedings

RECENTLY off the press is the "1954 Annual Proceedings Journal" of the Forest Products Research Society. The official account of the FPRS Eighth National Meeting held in May 1954 contains 43 papers from 8 technical sessions on: Packaging, Wood Composition Board, Wood Machining, Wood Drying, Wood Finishing, Glues and Gluing, Quality Control, and General subjects. It also contains reports on the 1954 Woodworker's Industry Show, the FPRS national meeting, the annual business meeting, subject matter committee meetings, and names and addresses of FPRS officers and administrative committees.

The FPRS 1954 Annual Proceedings is available in heavy paper cover form for $7 or with a hard-bound, cloth book cover at $9. It may be ordered from the Forest Products Research Society, P. O. Box 2010, University Station, Madison 5, Wis. Postage will be paid by the FPRS.

# PROFESSIONAL CARDS

**Commercial Testing and Research:**

- Chemical
- Metallurgical
- Physical
- Radiographic
- Spectrographic
- Sampling

---

**W. B. COLEMAN & CO.**
*Metallurgists-Chemists-Engineers*
Spectrographic Analysis
Chemical and Physical Testing
Metallurgical Investigations
Boiler Water Conditioning
Consultation Service
**9th & Rising Sun Ave., Philadelphia 40, Pa.**
Member: American Council of Independent Laboratories

---

**HERSEY INSPECTION BUREAU**
*ENGINEERING-TESTING-INSPECTION SERVICE*
For Architects, Engineers, Contractors & Manufacturers
Soil Mechanics & Foundation Engineering
Physical-Chemical-Metallurgical Testing
Gage & Tank Calibrations-Welding Certifications
3405 Piedmont Ave. Established
Oakland 11, Calif. 1931

---

SPECIALISTS IN: RESEARCH, DEVELOPMENT, QUALITY CONTROL OF WOOD PRODUCTS, ADHESIVES, COATINGS, FINISHES
CHEMICAL and PHYSICAL TESTING OF PRODUCTS MADE OF OR USED WITH **WOOD**
**TECO LABORATORY**
CHEMISTS, TECHNOLOGISTS, ENGINEERS
**TIMBER ENGINEERING CO.** 1319 18th St. N. W. WASHINGTON 6, D. C.

---

**LEDOUX & COMPANY, INC.**
*Chemists, Assayers, Engineers*
*Samplers and Weighers*
*Spectroscopists*
359 ALFRED AVENUE
TEANECK, NEW JERSEY
Member: American Council of Independent Laboratories

---

**THE JAMES H. HERRON COMPANY**
*Consulting—Testing—Inspection*
Chemical · Physical · Radiographic · Metallurgical
*Subsoil Examination—Concrete Control*
1360 W. 3rd Street, Cleveland 13, Ohio
Member: American Council of Independent Laboratories, Inc.

---

**PATZIG TESTING LABORATORIES**
ENGINEERING INSPECTION
TESTS • ANALYSIS • RESEARCH
—OF—
EQUIPMENT • APPLIANCES
MATERIALS & PRODUCTS
Ingersoll Ave. & 23rd St. Des Moines, Iowa

---

**SOUTHWESTERN LABORATORIES**
*Consulting, Analytical Chemists and Testing Engineers*
Member A.C.I.L.
Inspections, Testing and Chemical Work
Fort Worth, Dallas, and Houston, Texas

---

**PETROX LABORATORIES**
*Petrographic, X-Ray Diffraction and Differential Thermal Analysis*
Aggregates-Concrete-Industrial Products
1260 South York Street
Denver 10, Colorado

---

**ELECTRICAL TESTING LABORATORIES, INC.**
Electrical, Mechanical, Photometric, Radiometric, Chemical Laboratory and Associated Services
Certification, Inspections at Factories, and Field Investigations
2 East End Avenue *at* 79th St. New York 21, N.Y.

---

Consultation, Development and Research for
**RUBBER & PLASTICS INDUSTRIES**
and for raw material suppliers for same
R. R. OLIN LABORATORIES, INC.
*(Est. 1927)*
P. O. Box 372T, Akron 9, Ohio
Tel. HEmlock 4-3724

---

**SOUTHERN LABORATORIES, INC.**
Engineers — Chemists
Sub Soil Investigations
Physical, Chemical, and Soil Laboratories
Research & Inspection
Complete Model Shop
Mobile, Alabama New Orleans, La.

---

**CHARLES C. KAWIN COMPANY**
METALLURGICAL CHEMISTS
FOUNDRY and METALLURGICAL ENGINEERS
METALLOGRAPHERS—SPECTROGRAPHERS
PHYSICAL TESTS
431 S. Dearborn St. Chicago 5, Ill.
P.O. Box 2035 Buffalo 5, N. Y.
Member: American Council of Independent Laboratories

---

**DESERT SUNSHINE EXPOSURE TESTS**
7740 Ramona Road
Phoenix, Arizona
WE TEST ANYTHING UNDER THE SUN

---

**TRUESDAIL LABORATORIES, INC.**
Research — Consultation — Analyses — Testing — Charter Member ACIL
CHEMISTS · BACTERIOLOGISTS · ENGINEERS
Write for Brochure · 4101 North Figueroa Street
Los Angeles 65, California · CApitol 4148

---

**South Florida Test Service**
*Testing • Research • Engineers*
Consultants and specialists in corrosion, weathering and sunlight testing.
4201 N. W. 7th Street Established
Miami 34, Fla. 1931
Member: American Council of Independent Laboratories

---

Timber and Timber Treatment Inspections
Chemical and Physical Testing Laboratories
**A. W. Williams Inspection Company**
**Mobile, Alabama**
*Representatives Stationed throughout U.S.A.*
Established 1921 Member A.C.I.L.

---

**ROBERT W. HUNT COMPANY**
*Inspection, Tests, Consultation, Research*
**ENGINEERS**
CHEMICAL, PHYSICAL, METALLURGICAL, CEMENT and CONCRETE LABORATORIES
175 W. Jackson Blvd., CHICAGO, *And All Large Cities*

---

**LUCIUS PITKIN, INC.**
ESTABLISHED 1885
Metallurgical Chemists & Consultants
Analysis—Sampling—Assaying
Spectrography—Metallography
Corrosion Studies—Research
PITKIN BLDG. 47 FULTON ST., N. Y. 38, N. Y.
Member: American Council of Independent Laboratories

---

The Oldest Commercial Laboratory In America
**BOOTH, GARRETT & BLAIR**
Established 1836
*Analytical and Consulting Chemists*
*Samplers and Weighers*
228 South Ninth Street Philadelphia 7, Pa.

---

**PENNIMAN & BROWNE, INC.**
CHEMISTS - ENGINEERS
INSPECTORS
Laboratory and Field Services
*Inspection - Testing - Research*
Member: American Council of Independent Laboratories
341 ST. PAUL PLACE • BALTIMORE 2, MD.

---

**STILLWELL & GLADDING, INC.**
Inspection-Sampling-ANALYSIS of Chemicals, Drugs, Fats, Greases, Oils, Waxes, Fertilizers, Glycerine, DDT., B.H.C., Chlordane, etc., Pyrethrum, Rotenone Products, Soaps, Solvents, Tests, AOAC., ASTM., NF., USP., Tobacco. Est. 1868
130 Cedar Street, New York 6, N. Y.

# PROFESSIONAL CARDS

**Below and on previous page are announcements by leading organizations and individuals of their services.**

**SMITH-EMERY COMPANY**
Established 1910
*Chemists — Engineers*
Sampling, Analyzing, Assaying
Spectrography, Physical Testing
*Member: American Council of Independent Laboratories*
781 E. Washington Blvd. Los Angeles 21, Calif.

**CYRUS WM. RICE & COMPANY**
. . . ESTABLISHED 1916 . . .
15 NOBLE AVENUE, PITTSBURGH 5, PA.
INDUSTRIAL WATER CONSULTANTS

OTL
Oklahoma's Oldest Independent Testing Laboratory
Professional Engineers & Chemists
**OKLAHOMA TESTING LABORATORIES**
310 N. Klein P.O. Box 3838 Oklahoma City
Member American Council of Independent Laboratories

**Analytical Chemists of Cincinnati**
*Analysts — Consultants*
Salt Fog Testing
Dust Particle Surveys and Analysis
Spectrophotometric Assays
Sewage Analysis
Chemical Analyses, Asphalt, Chemicals, Concrete, Foods, Liquor, Water
4 West 7th St. Cincinnati 2, Ohio

**BOWSER-MORNER**
**TESTING LABORATORIES**
*Chemists — Engineers — Inspectors*
Laboratory Inspection and Tests—Chemical—Physical—Metallurgical—X-Ray—Diamond Coring—Environmental Testing
P.O. Box 51, Dayton 1, Ohio
Member: American Council of Independent Laboratories

**RESEARCH · TESTING · DEVELOPMENT**
in engineering, chemistry, metallurgy, textile technology, electronics, microbiology and psychometrics . . . from basic materials to finished products.
**UNITED STATES TESTING COMPANY, Inc.**
Hoboken, N. J.
BOSTON · PROVIDENCE · DENVER · MEMPHIS · DALLAS
CHICAGO · LOS ANGELES · NEW YORK · PHILADELPHIA
WILMINGTON

Your Professional Card here will cost less than 1/2 of one cent per reader.
Write ASTM BULLETIN for details.

**Phoenix Chemical Laboratory Inc.**
Petroleum Product Testing, Research & Development.
3953 Shakespeare Ave., Chicago 47, Ill.

**SHILSTONE TESTING LABORATORY**
*Chemists & Engineers*
Spectrographic Analyses*
New Orleans, La. *Houston, Tex.
Inspection at all leading industrial centers

**FILM MONITORING**
**PERSONNEL AND ENVIRONMENT**
ST. JOHN X-RAY LABORATORY
CALIFON, NEW JERSEY
1925–30th Anniversary–1955

**Omaha Testing Laboratories**
*Chemists, Testing and Inspection Engineers*
Testing, Inspection, Consultation, Design of all types of building and paving materials.
Investigation of Foundation Soils
511 South 20th St. Omaha 2, Nebraska

**MEASUREMENTS CORP.**
RESEARCH & MANUFACTURING ENGINEERS
Harry W. Houck Martial A. Honnell
John M. van Beuren
Specialists in the Design and Development of Electronic Test Instruments
Boonton, N. J.

RESEARCH LABORATORIES
**FOSTER D. SNELL INC.**
29 WEST 15th ST. NEW YORK 11, N.Y. — WA 4-8800
CHEMISTS · ENGINEERS
Member: American Council of Independent Laboratories

**SOIL TESTING SERVICES, INC.**
Soil Investigations
Laboratory Testing
Engineering Reports
& Recommendations
3521 N. Cicero Ave., Chicago 41, Ill.
1105 E. James St., Portland, Michigan
621 E. Lake View. Ave., Milwaukee, Wis.

RESEARCH
DEVELOPMENT
QUALITY CONTROL
DTL
554 BAGLEY
PHONE WO 1-6528
DETROIT 26, MICH.
**THE DETROIT TESTING LABORATORY, INC.**

To ASTM Nonmembers: The Society welcomes inquiries on the "Advantages of Membership"

To the ASTM Committee on Membership
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on Membership in ASTM and include a membership application blank.

Signed_____

Address_____

Date_____

# PERSONALS...

**News items concerning the activities of our members will be welcomed for inclusion in this column.**

*NOTE—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

**James Adams, Jr.,** has been appointed Chief Engineer, Research and Product Design, Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J. Mr. Adams has been with the company since 1939, heading up research projects on fabrics, textiles, and other of R/M's products and components and their application to industry.

**Herbert G. Arlt,** Materials Specification Engineer, Bell Telephone Laboratories, Murray Hill, N. J., has been elected Vice-President of the Standards Engineers Society.

**R. C. Bardwell,** retired Superintendent of Water Service, Chesapeake & Ohio Railway Co., now residing in Mount Dora, Fla. (P. O. Box 151), has been named an Honorary Member of the Committee on Convention Arrangements of the American Railway Engineering Association, in recognition of his long and valued service on this committee.

**Howard S. Bean,** Chief of the Capacity, Density and Fluid Meters Section of the National Bureau of Standards, Washington, D. C., received the Worcester Reed Warner Medal of The American Society of Mechanical Engineers, presentation being made at the ASME founding anniversary meeting in New York City in February. The Medal is bestowed for outstanding contributions to permanent engineering literature. Mr. Bean was recognized for his writings in the field of flow measurement, the citation reading: "For his valuable contributions to the art and science of fluid metering and his unselfish work in preparing the many authoritative publications on this subject, particularly the widely used reports of the ASME Fluid Meters Research Committee." In ASTM, Mr. Bean is active in Committees D-3 on Gaseous Fuels, E-1 on Methods of Testing, and E-8 on Nomenclature and Definitions.

**Earle S. Bidgood,** until recently Chief Chemist, Allen D. Cardwell Electronics Products Corp., Plainville, Conn., has accepted a position with the Superior Tube Co., Photoforming Div., Stamford, Conn.

**Richard A. Biggs,** formerly Director of Development, Franki Foundation Co., New York City, is now Manager of Product Development, Crucible Steel Company of America, in the same city.

**Lloyd R. Bittle,** until recently with the Canadian General Electric Co., Ltd., Davenport Works, Toronto, is now Chief Methods Engineer, General Steel Wares, Ltd., Adelaide Plant, London, Ont., Canada.

**C. W. Bowler,** Standards Engineer, Leeds & Northrup Co., Philadelphia, Pa., has been elected Secretary of the Standards Engineers Society.

**S. A. Braley,** of the Mellon Institute of Industrial Research, was honored by selection by the Pittsburgh Junior Chamber of Commerce as one of Pittsburgh's Men-of-the-Year. The Jaycees annually choose a representative from each of a number of professions, in recognition of significant accomplishments. Dr. Braley, selected to represent the profession of scientific research, has been associated with Mellon Institute since 1927, for many years conducting research on the Steel Fellowship supported by Pittsburgh Steel Co., and since 1946 heading the Mine Acid Control Fellowship originally sponsored by the Pennsylvania Sanitary Water Board and now supported by the bituminous coal industry. This has been the first concerted effort to study the basic aspects of the difficult and frustrating stream pollution problem existing in most coal mining areas from discharge of acidic mine water, correction of the situation being especially perplexing because more than half the mine water flows from abandoned workings. Although a complete solution to the problem has not been found, Dr. Braley published, in February, 1954, a widely acclaimed, 300-page report describing the fundamental mechanism of acid formation and suggesting procedures for its control. In ASTM, Dr. Braley has been active for many years in Committee D-19 on Industrial Water.

**Francis M. Buresh,** formerly with the Curlator Corp., East Rochester, N. Y., is now President, Buresh Nonwovens, Inc., Northampton, Mass.

**Philip D. Comstock** is now General Manager, R. W. Green Jr. and Co., Louisville, Ky. He was previously with the Ohio River Sand Co., in the same city.

**R. N. Conners,** Executive Vice-President of Chase Bag Co., Chagrin Falls, Ohio, was elected President of the Textile Bag Manufacturers Assn. at its annual meeting in New Orleans in February.

**Leon D. Cook, Jr.,** formerly Materials Engineer, Research Dept., Wyandotte Chemical Corp., Wyandotte, Mich., is now District Sales Engineer, Bart Mfg. Co., Detroit, Mich.

**Charles B. Crandall,** formerly Statistician, Cotton Merchandising Research, University of Texas, Austin, is now Quality Control Statistician, United States Testing Co., Inc., Hoboken, N. J.

**Clayton L. Davis** has been named Technical Service Director, Universal Atlas Cement Co., New York City, succeeding the late Earl R. Bryant.

**P. S. Denning** has retired from F. E. Schundler and Co., Inc., Joliet, Ill. He had represented his company for a number of years in the Society and on Committees C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements, and D-21 on Wax Polishes and Related Material; also represented the Oxychloride Cement Assn. on ASA Sectional Committee A88 on Magnesium Oxychloride Cement Flooring. Norbert Becker, Technical Director, will now represent Schundler and Co. in the Society and in technical committee work.

**James T. Eaton** fills the new position of Vice-President of Production at E. F. Houghton & Co., Philadelphia, Pa. He was formerly Director of Research, and continues to head the research staff in addition to assuming responsibility of Houghton's oil manufacturing plants.

**J. L. Eigenbrot,** Assistant to President, General Coal Co., Philadelphia, Pa., has retired. He had represented his company for many years in the Society and on Committee D-5 on Coal and Coke. The company membership (maintained for many years in Philadelphia) is now being transferred to Big Stone Gap, Va., and J. N. Shupe, Director of Preparation Control, has been named to serve as company representative.

**William P. Gano** has retired as Assistant Manager, Penn-Dixie Cement Corp., Nazareth, Pa. Affiliated with ASTM for many years, both as an individual member and as representative of the company membership, Mr. Gano had been active in Committee C-1 on Cement.

**Ray C. Giddings,** formerly Chief Engineer, River Industries, Inc., Seneca, is now Field Engineer, Pittsburgh Testing Laboratory, Portland, Ore.

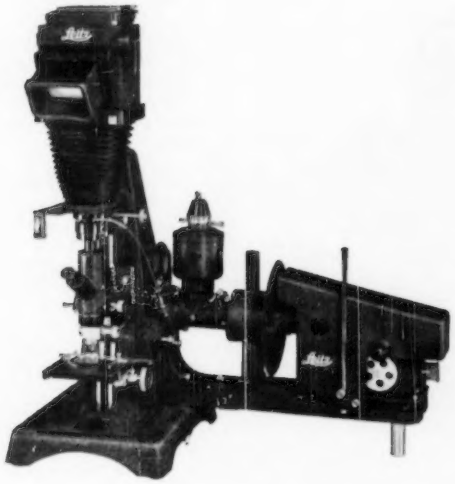
**William L. Glowacki** has been appointed Assistant Director of Research of Eastern Gas and Fuel Associates, Boston, Mass. A recognized authority on coal chemicals, Mr. Glowacki has been associated with the research group at Eastern since 1947.

**Oliver M. Hayden** has been named Assistant Director of Sales, Rubber Chemicals Division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

**Manley R. Hoppe,** Vice-President, Parr Instrument Co., Moline, Ill., has been elected President of the Associated Industries of the Quad-Cities, an association of 87 manufacturers in the area served by

*(Continued on page 74)*

## LEITZ PANPHOT METALLOGRAPHIC MICROSCOPE



Permanently aligned microscope, camera and light source are combined in one compact unit for easy metallurgical research. With the Panphot, you shift instantaneously from observation to photography by moving a prism in the body tube. A large image then appears on the ground glass screen in the mirror-reflex camera.

The Panphot has a low-voltage filament lamp for visual observation and an arc lamp for photomicrography. It is fitted for study of polished metal specimens under magnifications ranging from lowest to highest power. Ultropak illuminator for dark-field observations available.

Accessories equip the Panphot for every type of photomicrography, photomacrography and for drawing and projecting micro-images.

Leitz
microscopes
binoculars
Leica cameras
lenses

**E. LEITZ, INC.**
*Distributor of the world-famous products of Ernst Leitz, Wetzlar, Germany*

**E. Leitz, Inc.,** *Dept. TM*
*468 Fourth Avenue, New York 16, N. Y.*

Please send me your brochure on the Leitz Panphot Metallographic Microscope.

*Name* _____

*Company* _____

*Street* _____

*City* _____ *State* _____



# POLAROGRAPH

Trademark Reg. U.S. Pat. Off.

## SARGENT Chart Recording

## MODEL XXI

***Uses are varied and many for the SARGENT POLAROGRAPH***

1. For the routine analysis of non-ferrous alloys and ores when determining minor constituents including copper, lead, cadmium, zinc, manganese, iron and cobalt.
2. For the routine determination of lead, copper, nickel, manganese and cobalt in ferrous alloys.
3. For the analytical control of plating baths, notably in the field of precious metals.
4. For trace metal measurements in food products, in body fluids and in petroleum products.
5. For the analysis of source materials and processed products for a variety of hormones and vitamins.
6. For the identification and estimation of numerous substances of nutritional and biological regulatory function, supporting or replacing biological assay.
7. For the determination of halides and sulfate groups by titration with a polarized electrode.
8. For the analytical measurement of innumerable organic compounds containing reducible groups.
9. For specific industrial controls such as the estimation of aldehydes in alcoholic products, the quantitative differentiation of sugars and the control of aging quality in sugars.
10. For the measurement of dissolved oxygen, oxygen demand and metal ions in water and sewage.
11. For many uncommon analyses for which classical procedures are unavailable, less accurate and slower.
12. For the investigation and control of commercial reduction processes.
13. For thermodynamic investigations relating to states of ionic aggregations, mobilities and diffusion rates, solubilities, reaction rates and equilibrium constants.

***For a complete description of the Sargent Polarograph Model XXI, write today.***

**S-29303** POLAROGRAPH—Model XXI Visible Chart Recording, Sargent. For operation from 115 Volt 50/60 cycle circuits.....**$1875.00**

## SARGENT

NEW SARGENT CATALOG NOW AVAILABLE

SCIENTIFIC LABORATORY INSTRUMENTS · APPARATUS · SUPPLIES · CHEMICALS
E. H. SARGENT & COMPANY, 4647 W. FOSTER AVE., CHICAGO 30, ILLINOIS
MICHIGAN DIVISION, 1959 EAST JEFFERSON STREET, DETROIT 7, MICHIGAN
SOUTHWESTERN DIVISION, 5915 PEELER STREET, DALLAS 9, TEXAS

*(Continued from page 72)*

cities of Moline, East Moline, and Rock Island, Ill., and Davenport, Iowa.

**Joseph Hyman** has been elected Vice-President and Technical Director of Catalin Corp. of America. He will be in charge of research and development, quality control, and technical service for the company's three plants. He has been with the company since 1945.

**George W. Jernstedt** has been appointed director of a new manufacturing laboratory of the Westinghouse Electric Corporation to develop improved methods, techniques, and equipment for manufacturing needs. For the present it will utilize facilities already existing in Pittsburgh.

**Warren Cottle Johnson,** of the U. S. Navy Department, formerly Materials Engineer, Materials Testing Laboratory, Base Development, Agana, Guam, is now stationed in Honolulu, Hawaii, as Laboratory Branch Manager, Materials Testing Division.

**Maurice G. Kramer** recently has been promoted to Director of Application Research for Wyandotte Chemicals Corp., Wyandotte, Mich. John J. Cramer has been named to succeed Mr. Kramer as Supervisor of the Laundry and Textile Research Department.

**Donald L. LaVelle,** formerly Research Metallurgist in the Central Research Laboratory, American Smelting and Refining Co., has been appointed Assistant Manager of the Aluminum Department. Mr. LaVelle's office will be located at the company's Perth Amboy (N. J.) plant.

**James R. Long,** formerly on the Metallurgical Advisory Board, National Academy of Sciences, Washington, D. C., is now Metallurgist, Harvey Machine Co., Torrance, Calif.

**Douglas C. Lynch,** formerly Executive Vice-President of Brush Electronics Co., Cleveland, Ohio, has been named President of the company.

**Kenneth G. Mackenzie,** Petroleum Consultant, Westport, Conn., and Chicago, Ill. (retired Vice-President, Texaco Development Corp.) and ASTM Past-President and Honorary Member, was awarded Certificate of Appreciation by the Society of Automotive Engineers, in recognition of outstanding contribution to the work of the SAE Fuels and Lubricants Technical Committee.

**Francis A. McAdam,** formerly Technical Sales Engineer, Dewey & Almy Chemical Co., Cambridge, Mass., is now Director of Research and Development, Huron Portland Cement Co., Detroit, Mich.

**Louis McDonald,** for the past three years Laboratory Director of Kelite Products, Inc., manufacturers of industrial chemicals, Los Angeles, Calif., has been elected to the office of Vice-President and Technical Director.

The **National Screw Machine Products Association** (composed of 280 manufacturers of screw machine products located throughout the United States, Canada, and Australia) elected Stuart R. Booker, of the Federal Screw Works of Detroit and Chelsea, Mich., to the Board of Trustees of the Association.

The **Portland Cement Association** has announced the appointment of James D. Piper to the position of Vice-President for Promotion, with headquarters in the Association's General Office, 33 West Grand Ave., Chicago 10, Ill. Mr. Piper succeeds W. D. M. Allan, who has been appointed Vice-President and Secretary of the Association.

**David Kenneth Powell,** formerly with Union Spring and Manufacturing Co., New Kensington, Pa., is now Sales Engineer, Motch & Merryweather Machinery Co., Pittsburgh, Pa.

**Gerald Reinsmith,** for the past two years with Narmco Neltbond Co., Chino, Calif., is now with the Research & Development Div., Headquarters Ordnance Weapons Command, Rockford, Ill. Prior to his association with the Narmco Co., Mr. Reinsmith wa. Materials Engineer, Office Chief of Ordnance, U. S. Department of the Army, Washington, D. C.

**Jacob Shatzky,** formerly with the Margon Corp., Bayonne, N. J., has accepted a position as Mechanical Engineer with Taller & Cooper, Inc., Brooklyn, N. Y.

**Opal L. Sherburne** is now Supervisor, Antara Services, General Aniline and Film Corp., Linden, N. J. Until recently he had been Manager of Services Dept., Antara Chemical Division, General Dyestuff Corp., New York City.

**Maurice J. Sinnott** of the Department of Chemical and Metallurigcal Engineering at the University of Michigan (Ann Arbor) was awarded $2000 by the American Society for Metals as one of the outstanding teachers in the metallurgical profession. Dr. Sinnott for many years has been associated with the University's Engineering Research Institute on projects dealing with the metallurgy of stainless steel and titanium.

**C. E. Sloan** recently retired as Engineer of Bridges and Buildings, The Baltimore & Ohio Railroad Co., Baltimore, Md.

**S. S. Steinberg,** Dean of the College of Engineering, University of Maryland, is one of eight educators, diplomats, and scientists to receive from the University of Florida a Certificate of Merit for his work in inter-American relations. Dean Steinberg recently was on a trip in the South American and Caribbean area where he studied technical education and engineering for the Foreign Operations Administration.

**William S. Stephens** has joined the Materials Handling Department of Syntron Co., Homer City, Pa., as Application Engineer. He formerly was District Construction Engineer for the Pennsylvania Department of Highways.

**Henry R. Stevens,** formerly Engineering Consultant, Technical Associates, Paterson, N. J., is now Quality Control Engineer, The Philip Carey Manufacturing Co., Lockland, Cincinnati, Ohio.

**Studebaker-Packard Corp.,** Detroit, Mich., elected **William H. Graves** Vice-President and Director of Engineering for both lines of cars. He is succeeded as Chief Engineer of the Packard Division by **Herbert L. Misch.**

**Harold R. Suter** has joined the staff of the Catalytic Combustion Corp., Detroit, Mich. In his new position as Vice-President in Charge of Research and Development, Mr. Suter will be responsible for new and special product applications, and will be available for customer consultation in the many new fields of Air Pollution Control being served by Catalytic Combustion Systems. Mr. Suter has been associated with Wyandotte Chemicals Corp., Wyandotte, Mich., for the past 13 years as Director of Application Research. Prior thereto he was Assistant Professor of Chemistry, Detroit Institute of Technology. For several years Mr. Suter has been serving as Secretary of ASTM Committee D-12 on Soaps and Other Detergents.

**Paul L. Suter,** formerly Power Conservation Engineer, National Aniline Div., Allied Chemical and Dye Corp., Buffalo, N. Y., is now Power Engineer, St. Regis Paper Co., Deferiet, N. Y.

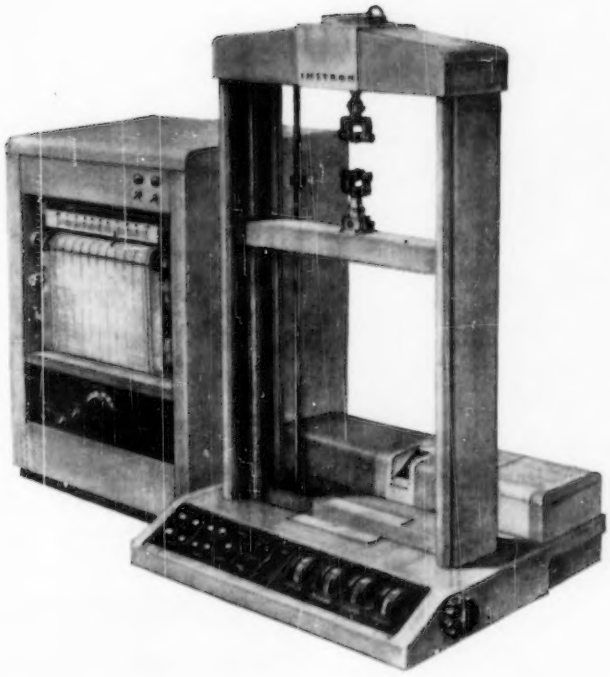
**Philip V. Tarr,** until recently Chief Engineer, Kwikset Powdered Metal Products, Anaheim, Calif., is now Consulting Engineer, Great Lakes Screw Corp., Chicago, Ill.

**Edwin Francis Van Over,** formerly with Procon, Inc., Des Plaines, Ill., is now associated with McDonald Engineering Co., Chicago, Ill., as draftsman.

**E. A. Williams, Jr.,** has accepted position as General Manager, Eastern Switchgear Div., Federal Pacific Electric Co., Scranton, Pa. He was previously with the R & IE Equipment Div., I-T-E Circuit Breaker Co., Greensburg, Pa.

## New Standard Sample Issued by the National Bureau of Standards

A NEW standard sample No. 167 of cobalt-base heat-resisting alloy is now available with a provisional certificate of analysis for the following constituents: C 0.38, Mn 1.64, P 0.010, S 0.007, Si 0.44, Cu 0.03, Ni 20.65, Co 42.90, Fe 2.13, Cr 20.00, V 0.01, Mo 3.90, W 4.50, Nb 3.15, Ta 0.08. The price of this standard is $5 per 150-g unit.



*the* **NEW** *table model* **INSTRON**

**Compact · Economical · Accurate · Sensitive · Versatile**

**LOAD RANGE: 10 GRAMS TO 200 POUNDS**

Now – the proven advantages of the INSTRON Universal Testing Instrument in a *compact*, yet versatile table unit. Its substantially LOWER PRICE permits use for *quality control* as well as for research.

Write for new facts file now.

**INSTRON** ENGINEERING CORPORATION

*440 Hancock Street, Quincy 71, Massachusetts*

# Mullen Testers

Built to
A.S.T.M.
Specifications

Also Available in Capacities
up to 1500 Pounds
Bursting Strength

B. F. PERKINS & SON, Inc.
HOLYOKE, MASSACHUSETTS

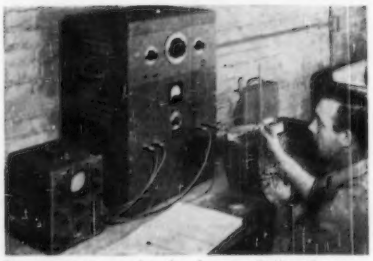
# TEST FOR STRENGTH

## *Non-Destructively* with the ELECTRO SONOMETER!

ELIMINATES costly sampling

SAVES material, time, labor

*Conforms to equipment specified in ASTM designation C 215-52 T*



Sonometer in use by the Sumner Sollitt Co., Chicago, for testing concrete and mortar mixes subjected to repeated freezing and thawing.

This versatile equipment easily measures torsional and flexural characteristics of most solid masses including metals. It accurately tests such masses weighing up to 1500 pounds. Portable Pickup and Driver can be used at a distance from the cabinet for testing heavy or bulky objects.

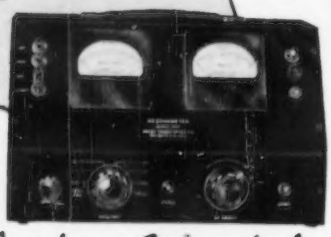
*Used* by industry, technical schools, utilities and government for testing metals and other solid materials such as carbon, masonry, plastics, concrete, compressed wood, etc.

***Write for FREE BULLETIN and name of your EPL Field Engineer***

Electro

**ELECTRO PRODUCTS LABORATORIES**
4501-A-TMs Ravenswood Ave. • Chicago 40, Ill.
*Canada:* Atlas Radio Corp., Ltd., Toronto, Ont.

# NEW VARIABLE TEST VOLTAGE MEGOHMMETER



*A New Companion to the Industry Accepted*

## 1020-B MEGOHMMETER

The Freed Type 1620 is a versatile insulation resistance measurement instrument with a continuously variable DC test potential from 50 to 1000 volts.

Components such as transformers, condensers, motors, printed circuits, cables and insulation material can be tested at their rated voltage and above, for safety factor.

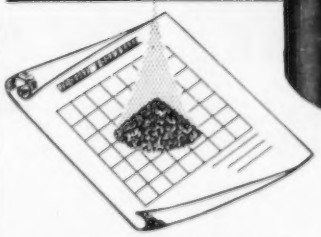
- Resistance — 0.1 megohms to 4,000,000 megohms.
- Voltage — variable, 50 - 1000 volts.
- Accurate — plus or minus 5% on all ranges.
- Simple — for use by unskilled operators.
- Safe — high voltage relay controlled.

**SEND FOR COMPLETE TRANSFORMER AND INSTRUMENT CATALOGS**

**FREED TRANSFORMER CO. INC.**
1733 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.

# High Speed • Accurate Sizing of Test Samples with SYNTRON

## "Vibratory" TEST SIEVE SHAKERS



Simple, easy to operate. Time and speed can be controlled to meet requirements of any sieve analysis. High speed operation—portable—operate on ordinary 110 volt, a-c (220 volt to order).

Write for Complete Catalogue Data—FREE

- Eliminate Guesswork —Insure Uniform Test
- Electromagnetic—No Gears, Cams, Belts, Etc.
- Reset Timer Provides Accurately Timed Tests
- Has 6 Standard 8 inch Sieves and Bottom Pan

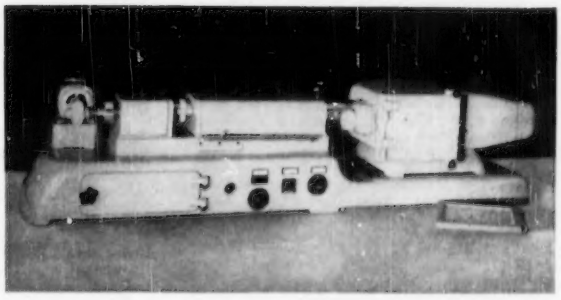
**SYNTRON COMPANY**
444 Lexington Homer City, Pa.

**The Amsler Horizontal Tensile Testing Machine** has been designed for testing materials of small section or low tensile strength such as fine wires, foils, fibers, fabrics, paper, yarn, leather, rubber, etc. The long horizontal design permits easy access to all parts, unobstructed view of the specimen, convenient gripping mechanisms and sufficient travel for specimens of great elongation such as rubber.

All of the desirable features in a small testing machine are included, such as the highly accurate pendulum load weighing system, five load ranges for greatest sensitivity at all loads, and speed control variable through eight steps from 0.1 to 20 inches per minute.

The tensile load applied is balanced by the deviation of the pendulum from the vertical position. The movement of the pendulum is indicated on a straight line scale located in front of the operator for easy reading. The pointer remains at the maximum load after fracture of the sample. The recording drum is located directly below the load scale. The recorder will plot the elongations as 1/5 size, actual size or double size.

A split nut arrangement on the pulling grip allows quick positioning of this grip to accommodate different length specimens. A wide variety of jaws and clamps are available for holding the different samples.



**The Chevenard Micro Tensile Testing Machine** has been designed for testing materials of very low strength or of micro dimensions. Samples with a breaking strength as low as one gram (0.035 oz.) may be tested. The machine, however, is extremely versatile having a maximum capacity of 100,000 times the minimum capacity of 100 kg. (220 lbs.). This broad range is obtained by the use of interchangeable dynamometer springs. The pulling speed can be varied between 6 and 300 mm. (0.24 and 12 in.) per minute. This is accomplished by the use of a variable speed motor and a sliding gear change box.

Two interchangeable optical tripods utilizing a light beam and photographic recording provide the utmost sensitivity in the measurement of elongation and the recording of stress-strain curves. Specimens can be tested dry or in a liquid bath and may be from 2 to 150 mm. (0.08 to 6.0 in.) between grips. The grips will accommodate specimens up to 6 mm. (0.24 in.) wide.

A micrometer and accessories are included for carrying out load-elongation cycles between two given values of elongation. The tester is also equipped with an automatic device for carrying out cycles between two given values of the load.

All of these features make the tester ideal for research or control tests on wire or thin metal strip, natural or artificial fibers and textiles, threads, tissues, paper, films of paint or varnish or similar materials.

*Prompt delivery on these machines can be made from stock now in U. S. A.*

**AMSLER LINE OF PHYSICAL TESTING APPARATUS**

| | | |
|---|---|---|
| Abrasion Testers | Dynamometers | Presses |
| Calibrators | Extensometers | Pulsators |
| Cement Testers | Gauge Testers | Tension Indicators |
| Chevenard Micro Testers | Hardness Testers | Torsion Testers |
| Creep Testers | Volume Meters | Vertical & Horizontal Tensile Testers of All Sizes |
| | Impact Testers | |

**ADOLPH I. BUEHLER METALLURGICAL LABORATORY APPARATUS**

| | | |
|---|---|---|
| Colorimeters | Magnifiers | Spectrographs |
| Comparators | Metallographs | Titrators |
| Dilatometers | Microscopes | Wide Field Microscopes |
| Laboratory Furnaces | pH Meters | |
| Measuring Microscopes | Pyrometers | |
| | Refractometers | |

Adolph I. Buehler
OPTICAL INSTRUMENTS
2120 GREENWOOD AVENUE, EVANSTON, ILLINOIS

# NEW MEMBERS . . . . . .

*The following 119 members were elected from January 19 to February 23, 1955, making the total membership 7817. . . . . Welcome to ASTM*

Note—Names are arranged alphabetically—company members first, then individuals

### CHICAGO

**Creamery Package Manufacturing Co.,** Alden H. Wakeman, Director of Research, Fort Atkinson, Wis.

**Balton, Walter,** Foundry Superintendent, Link-Belt Co., 300 W. Pershing Rd., Chicago 9, Ill.

**Brouse, Vernon S.,** Plant Superintendent, Apollo Metal Works, 66th Pl. and S. Oak Park Ave., Chicago 38, Ill.

**Elston, Judson D.,** Manager, Research Lab., General Box Co., 1825 Miner St., Des Plaines, Ill.

**Herbst, Clarence A.,** President, Biwax Corp., 3445 Howard St., Skokie, Ill.

**Jones, Paul W.,** Chemical Engineer, Rostone Corp., 136 Earl Ave., Lafayette, Ind.

**LaPine, R. J.,** Vice-President, Arthur S. LaPine and Co., 6001 S. Knox Ave., Chicago 29, Ill.

**Kempka, Gilbert E.,** Metallurgist, Johnson Motors, Lake Front, Waukegan, Ill.

**Nordberg, Bror,** Editor, "Rock Products," 309 W. Jackson Blvd., Chicago 6, Ill.

**Radke, A. O.,** Chief Experimental Engineer, Bostrom Manufacturing Co., 133 W. Oregon St., Milwaukee 4, Wis.

**Randall, Pryor N.,** Project Engineer, Engineering Research Dept., Standard Oil Co. (Indiana), 2400 New York Ave., Whiting, Ind. For mail: 2119 Hawthorne Rd., Homewood, Ill.

**Reahard, Daniel F., Jr.,** Engineering Dept., H. O. Canfield Co., 129 Housatonic Ave., Bridgeport, Conn. For mail: 487 W. Huntington St., Wabash, Ind.

**Wallace, S. R.,** Western Sales Manager, Special Products, U. S. Pipe and Foundry Co., 122 S. Michigan Ave., Chicago 3, Ill.

**Youngman, Ed. C.,** Chief Mechanical Engineer, Mead and Hunt, Inc., 550 State St., Madison 3, Wis.

### CLEVELAND

**National Screw Machine Products Assn.,** Orrin B. Werntz, Executive Secretary, 2860 E. 130th, Cleveland 20, Ohio.

**Almirall,** Francis C., Architect, Almirall & Coughlin, Epping Rd., Gates Mills, Ohio.

**Apellániz, J. A.,** Engineer, Owens-Corning Fiberglas Corp., Case Ave., Newark, Ohio. For mail: 323 N. Twenty-first St., Apt. C., Newark, Ohio. [J]*

**Beerman, Rafael,** Structural Engineer, Wellman Engineering Co., Cleveland, Ohio. For mail: 11508 Superior Ave., Cleveland 6, Ohio.

**Carpenter, Otis R.,** Executive Assistant, Babcock & Wilcox Co., Box 71, Barberton, Ohio.

**Horiak, Erwin A. V.,** Chief Engineer, Hercules Motors Corp., 101 Eleventh St., S. E., Canton, Ohio.

**Minto, Robert E.,** Metallurgist, Jones & Laughlin Steel Corp., 3341 Jennings Rd., Cleveland 1, Ohio.

**Perkins, Walter W.,** Chief Ceramist, U. S. Stoneware Co., Box 350, Akron 9, Ohio.

### DETROIT

**Gillig, Ferd,** Head, Aviation Technical Service, Ethyl Corp., 1600 W. Eight Mile Rd., Ferndale 20, Detroit, Mich. For mail: 404 W. Thirteen Mile Rd., Royal Oak, Mich.

**Greenberg, Maurice,** Chief, Testing and Research, City of Detroit, Department of Public Works, City Engineers, 12255 Southfield Rd., Detroit, Mich. For mail: 19791 Strathmoor Ave., Detroit 35, Mich.

**Kallenbach, Rudolf,** Research Chemist, Research Dept., Parker Rust Proof Co., 2177 E. Milwaukee Ave., Detroit 11, Mich.

**Kramer, Maurice G.,** Director of Application Research, Wyandotte Chemicals Corp., Wyandotte, Mich.

**Pearson, Harold W.,** Senior Associate Mechanical Engineer, City of Detroit Public Lighting Commission, 5425 W. Jefferson, Detroit 9, Mich.

**Ross, Stuart T.,** Research Metallurgist, Chrysler Corp., Box 1118, Detroit 31, Mich. For mail: 1698 Graefield Rd., Birmingham, Mich.

### NEW ENGLAND

**New England Concrete Pipe Corp.,** F. A. Trautner, Vice-President, Newton Upper Falls, Mass. For mail: 99 Needham St., Newton Upper Falls, Mass.

**Carpenter, Leon G.,** Research Director, Glas-Kraft, Inc., Mill St., Lonsdale, R. I.

**Karpovich, George P.,** Test Engineer, Titeflex, Inc., Hendee St., Springfield, Mass.

**Muller, Robert Arthur,** Senior Vice-President and Director, Atlas Plywood Corp., 1532 Statler Bldg., Boston 16, Mass. For mail: Happy Landings Farm, New London, N. H.

**Ollila, L. W.,** Metallurgical Manager, Wyman-Gordon Co., 105 Madison St., Worcester 1, Mass.

**Schumacher, F. W.,** Manager, Everett Refinery, Esso Standard Oil Co., 30 Beacham St., Everett 49, Mass.

### NEW YORK

**Broughton, William Waite,** Technical Representative, Newton New Haven Co., West Haven, Conn. For mail: 1063 Whitney Ave., Hamden, Conn.

**Calistro, Joseph Roger,** Quality Control Manager, Connecticut Hard Rubber Co., 407 East St., New Haven, Conn.

**Cameron, D. J.,** Executive Vice-President, The Fireproof Products Co., Inc., 138 Bruckner Blvd., Bronx 54, N. Y.

**Cascioli, A. F.,** Mechanical Engineering Dept., Consolidated Edison Company of New York, Inc., 4 Irving Pl., New York 3, N. Y.

**Cicio, S.,** Consultant, 209 South St., Elizabeth 4, N. J.

**Cloyes, William Parker,** Staff Assistant, Titanium Metals Corporation of America, 233 Broadway, New York, 7, N. Y.

**Coryell, R. L.,** Division Engineer, Consolidated Edison Company of New York, Inc., 4 Irving Pl., New York 3, N. Y.

**Farber, Littman,** Chemist, Bemerco Nickel and Alloys, 20 Carbon Pl., Jersey City, N. J. For mail: 35 Lyall Rd., Clifton, N. J.

**Feuchter, C. F.,** Technical Assistant to Vice-President, The American Oil Co., 122 E. Forty-second St., New York 17, N. Y.

**Fuchs, R. J.,** Group Leader (Research), Westvaco Mineral Products Div., Food Machinery and Chemical Corp., 500 Roosevelt Ave., Carteret, N. J.

**Kessler, Charles L.,** Chief Works Metallurgist, Aluminum Company of America, Massena, N. Y.

**Neisel, Robert H.,** Research Center, Johns-Manville Corp., Manville, N. J.

**Nisbet, Robert B.,** Associated Materials Engineer, Miller-Warden Associates, 731 Yale Ave., Swarthmore, Pa. For mail: Field Office, Miller-Warden Associates, 510 Franklin Ave., Nutley, N. J.

### NORTHERN CALIFORNIA

**Cen-Vi-Ro** Pipe Corp., S. R. Hubbard, Chief Engineer, Box 311, South Gate, Calif.

**Graebe, Frederick,** Teaching Assistant, University of California, Berkeley, Calif. For mail: 122 Hugo St., San Francisco 22, Calif. [J]

**Knight, Jack,** Architectural Draftsman, Utah Construction Co., Box 1549, Richmond, Calif. For mail: 818 Craft Ave., El Cerrito, Calif. [J]

**Luck, Henry A.,** 3315 Eleventh St., San Pablo, 10, Calif.

**Peickii, V. L.,** Director of Research, National Motor Bearing Co., Inc., Chestnut and Broadway, Redwood City, Calif.

**Sonoma County Sanitation Dept.,** Room 116, Court House, Santa Rosa, Calif.

### OHIO VALLEY

**New Castle Products, Inc.,** R. J. Piros, Technical Director, 1711 I Ave., New Castle, Ind.

**Gillette, Howard G.,** Chief Chemist, Precision Rubber Products Corp., 3110 Oakridge Dr., Dayton 7, Ohio. [J]

**Grossman, Harry G.,** Material Research Engineer, The Dayton Power and Light Co., 25 N. Main St., Dayton 3, Ohio.

**McLaughlin, Carl B.,** Executive Vice-President, Tube Turns Plastics, Inc., 224 E. Broadway, Louisville 1, Ky.

**Van Houten, G. R.,** Engineering Section Head, P. R. Mallory and Co., Inc., 3029 E. Washington St., Indianapolis, Ind. For mail: 101 Roosevelt Dr., Greenfield, Ind.

### PHILADELPHIA

**Biltz, F. W.,** Chief Engineer, Reading Co., Twelfth and Market Sts., Philadelphia 7, Pa.

**Lehigh University Library,** James D. Mack, Librarian, Bethlehem, Pa.

**Mulcey, Paul A.,** Consulting Engineer, 150 Horton St., Wilkes-Barre, Pa. For mail: RD #2, Dallas, Pa.

### PITTSBURGH

**Pittsburgh Plate Glass Co., Paint Division, Springdale Research Center, Technical Library,** Howard L. Gerhart, Director of Research, Springdale, Pa.

**Hickey, John,** Chemical Plants Div., Pittsburgh Coke and Chemical Co., Neville Island, Pittsburgh 25, Pa.

**Hocher, A. A.,** Chief Engineer, Hubbard and Co., 6301 Butler St., Pittsburgh, Pa.

**Lyall, George R.,** Assistant Chief Metallurgist, National Tube Div., United States Steel Corp., Christy Park Works, Box 570, McKeesport, Pa.

**Sherlock, Richard J.,** Assistant Works Manager, Union Steel Castings, Division of Blaw-Knox Co., 62nd and Butler Sts., Pittsburgh 1, Pa.

**Shipe, William P.,** General Supervisor, Specifications, United States Steel Corp., Metallurgical Dept., Irvin Works, Dravosburg, Pa.

### ST. LOUIS

**Hillyard Chemical Co.,** G. E. Hower, Chemist, Box 909, St. Joseph 1, Mo.

**Carter, T. S.,** Chief Engineer, Missouri-Kansas Texas Lines, 1526 Railway Exchange Bldg., St. Louis 1, Mo.

**Harper, Jack,** Box 508, Cairo, Ill.

**Lampertz, Richard W.,** Assistant Chief Chemist, Carter Carburetor Corp., 2840 N. Spring St., St. Louis 7, Mo.

**Musgrave, John R.,** Chief Technical Service (Research), The Eagle Picher Co., Research Labs., Box 290, Joplin, Mo. For mail: 518 N. Pearl, Joplin, Mo.

### SOUTHERN CALIFORNIA

**Becket, Welton,** Principal of Firm, Welton Becket, FAIA, and Associates, 5657 Wilshire Blvd., Los Angeles, Calif.

**Hines, John C.,** Ensign, U. S. S. Buck (DD761), United States Department of the Navy. For mail: 6762 Mohawk St., San Diego 15, Calif. [J]

**McCowan, R. B.,** The Fluor Corp., Ltd., Box 7030, E. Los Angeles Station, Los Angeles 22, Calif.

### SOUTHWEST

**Dolese Co., The,** W. G. Kellow, Assistant Engineer, Box 990, Oklahoma City 1, Okla.

**Houston Grinding and Manufacturing Co., Inc.,** O. H. Beal, President, 2110 Quitman St., Houston 10, Tex.

*(Continued on page 80)*

# Kodak reports to laboratories on:

**identifying very meagre samples . . . reviewing flames, fractures, and explosions . . . a possibly outmoded philosophy**

## Infrared beam squeezer

The lens you see here is not glass but silver chloride, which is transparent all the way out beyond 17$\mu$ in the infrared. The speck it magnifies is typical of specks for which we run infrared absorption spectra in the course of solving our daily little problems. We use such lenses not as magnifiers but to constrict one of the beams in a double-beam infrared spectrophotometer so that all its flux can be put through a 0.75mm x 3.5mm aperture. This permits the use of a very small sample. Then a second such AgCl lens collimates the beam again.

The samples, frequently weighing 50 micrograms or less, are handled by grinding the material to be examined with a little potassium bromide and compressing to a narrow strip. Nothing is dissolved in the process, and there is less chance for reactions and extra absorption that might mask the few micrograms of organic material we seek to identify. KBr puts no dips of its own into the chart.

This procedure is much less expensive than working out reflecting microscope optics and hitching them to a spectrophotometer. We got into it in identifying spots on film that our testing department won't let us sell. It might interest others who have only very meagre samples to work with, like those who study blood and other life juices.

Since most infrared spectroscopists aren't as lucky as we in having a great optical factory in the immediate family, we thought it would be a friendly deed if we made up a stock of silver chloride lenses for anybody who wants to try out this wrinkle of ours.

*The price is $102 for a set of* Kodak Infrared Microsample Optics, *consisting of an unmounted pair of plano-convex AgCl lenses of 24mm diameter and 22mm focal length, coated with a black $Ag_2S$ smoke that cuts out radiation below 1$\mu$, plus a similar plane-parallel plate for the reference beam. The deal is with Eastman Kodak Company, Special Products Sales Division, Rochester 4, N. Y. We'll throw in a set of mounting drawings or give you the name of an infrared equipment manufacturer who supplies the whole assembly ready to slip into his spectrophotometer. We can also supply reprints of our papers on the method.*

## Slicing time

If you would like to live over and over again a certain $\frac{2}{5}$ second sliced into 2,000 1.2-$\mu$sec slices, we have just the ticket for you.

The *Kodak High Speed Camera*, we admit with no shame at all, is not highbrow instrumentation.* It is a 16mm movie camera designed for and widely used by practical men with practical manufacturing problems to solve and impatient production chiefs to keep happy. Its controls are relatively few and unimpressive. Aside from a few photoflood lamps and maybe a stand, there is little auxiliary equipment for the assistant photographic engineer to tote.

With such an unsophisticated approach, you get an exposure time for each frame that is always $\frac{1}{5}$ the repetition rate. Since the camera speed range is 1000 to 3200 frames per second, this means that the time available for smearing out the image is 63 to 200 $\mu$sec. The distance moved by a machine part in this time, divided by the image-to-object size ratio, is rarely large enough for blurring.

Flames, fractures, and explosions are another matter. Here we do use extra equipment to illuminate the subject by repetitive flashes from a discharge lamp with enough output even for schlieren photography with the camera. A reluctance pickup gives a synchronizing pulse at the instant when each frame is in position. And that's how we get 1.2-$\mu$sec shavings from big, fat 63 to 200-$\mu$sec slices.

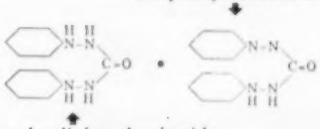
*The distinguished high speed photographic pioneers, Edgerton, Germeshausen & Grier, Inc., 160 Brookline Avenue, Boston 15, Mass., make this stroboscopic auxiliary equipment for the* Kodak High Speed Camera. *It is to them we suggest inquiries on this matter be directed. For a booklet on the camera itself, write Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N. Y.*

*Nevertheless, we venerate highbrows, particularly for what they do with our film.

## Behind the quotes

"*s-Diphenylcarbazone*" (Eastman 4459) appears in our catalog with a cynical pair of quotation marks around it. The punctuation betokens our essential honesty, indicating we know that Eastman 4459 is not really s-diphenylcarbazone. It is a double compound of

s-diphenylcarbazone



and s-diphenylcarbazide.

Sure, we can separate them, but that would greatly bump up the price of the reagent. Outmoded though the philosophy may be, we still feel that the cost of a reagent is of some practical importance. Besides, we're not so sure that separation of the components of this reagent would be a good idea.

After all, analysts have been buying it from us for years for argentometric titration of cyanides and mercurimetric titration of chlorides in biological fluids. To confuse the name of this tried and true reagent just because some academically minded organic chemists happen to know that in half the molecules the nitrogen bond has been reduced—that strikes us as a dirty trick.

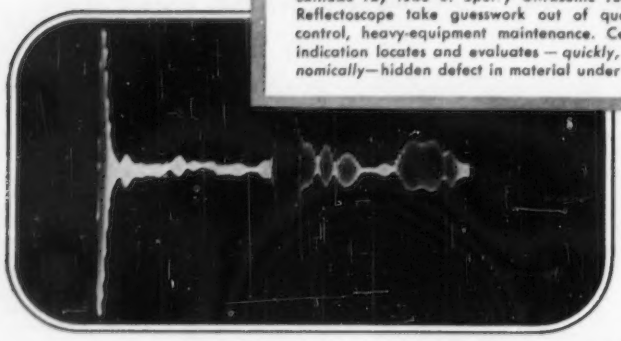
*Nothing (short of selling you 10 grams of "s-Diphenylcarbazone" for $3) would make us happier than sending you abstracts of the procedure for free. Also our List No. 39 of some 3500 Eastman Organic Chemicals, if you haven't received your copy as yet. Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).*

*Prices quoted are subject to change without notice.*

**This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere***

Kodak
TRADE-MARK

ACCURATE, EASY-TO-READ sound patterns on cathode ray tube of Sperry Ultrasonic Testing Reflectoscope take guesswork out of quality-control, heavy-equipment maintenance. Center indication locates and evaluates — *quickly, economically*—hidden defect in material under test.



# How to be SAFE with SOUND!

**. . . in quality-control, heavy-equipment maintenance**

Take your cue from thousands of manufacturers (large and small) in dozens of industries: Solve your quality-control and heavy-equipment maintenance problems with the portable, nondestructive testing instrument that lets you "look inside" metals and other materials . . .

**The Sperry Ultrasonic Testing**
**REFLECTOSCOPE**

**Cut wasted machine- and man-hours by locating and evaluating both surface and internal defects in your stock materials BEFORE EXPENSIVE MACHINING.**

**Eliminate costly production delays by discovering fatigue cracks in your heavy equipment BEFORE THEY LEAD TO BREAKDOWN.**

**Speed and improve inspection of your critical finished parts.**

**SPERRY PRODUCTS, INC.**
Leader Since 1928 in Nondestructive Testing

*YOUR FIRST MOVE: Fill out and mail coupon below and let us send you a free copy of our new Technical Bulletin 50-105 giving full details.*

Sperry

Sperry Products, Inc
1704 Shelter Rock Road
Danbury, Connecticut

☐ Please send me a copy of your new Technical Bulletin 50-105 giving full details on the Sperry Ultrasonic Testing REFLECTOSCOPE.

☐ Have your representative call.

Materials to be tested_____

Name _____

Title _____

Company _____

Street _____

City _____ Zone ___ State _____

☐ Please tell me how to arrange for free showing of 10-minute sound-color film explaining theory and application of ultrasonic testing.

See catalog lh-Sp in Sweet's 1954 Plant Engineering File


(*Continued from page 78*)

**El Paso, City of, Public Service Board, Municipal Water and Sewer System,** Box 511, El Paso, Tex.

**Stewart, R. L., Jr.,** Product Quality Engineer, Wedgeplug Valve Co., Inc., 1300 S. Broad Ave., New Orleans 15, La.

**Weiher, Earl R.,** Chief of Process Control, Convair, A Division of General Dynamic, Corp., Fort Worth, Tex. For mail: 6157 Calmont Ave., Fort Worth 16, Tex.

WASHINGTON (D. C.)

**Dayett, Gurney H.,** Assistant to Engineer of Bridges and Buildings, The Baltimore and Ohio R. R. Co., 1301 Baltimore and Ohio Bldg., Baltimore 1, Md.

**Dickerson, N. K., Jr.,** Dickerson, Inc., Monroe, N. C.

**Thomas, E. O.,** Quality Control, Reynolds Metals Co., Third and Grace Sts., Richmond 19, Va.

WESTERN NEW YORK-ONTARIO

**Deline, Harold G.,** Laboratory Manager, Dunlop Canada, Ltd., 870 Queen St., E., Toronto, 8, Ont., Canada.

**Dingle, Arthur Durwin,** Research Physicist, Dunlop Research Centre, 870 Queen St., E., Toronto 8, Ont., Canada.

**Kovacsev, Frank S.,** Welding Engineer, Linde Air Products Co., Division of Union Carbon and Carbide Corp., E. Park Dr. and Woodward ave., Tonawanda, N. Y.

**Mancini, Joseph A.,** Manager of Forging Operations, Burke Steel Co., Inc., 30 Shere St., Rochester 2, N. Y. For mail: 144 Edgemont Rd., Rochester 20, N. Y.

**O'Gee, Russell C.,** Director of Research, O-Cel-O Division of General Mills, Inc., 1200 Niagara St., Buffalo 13, N. Y.

**Quirk, John H.,** New Test Methods Engineer, The Carborundum Co., Coated Products Div., Niagara Falls, N. Y.

**Whitcomb, C. E.,** Vice-President, McLain Construction Corp., 275 Mayville Ave., Kenmore 17, N. Y.

**York, The Corporation of the Township of,** O. M. Falls, Commissioner of Works, 2700 Eglinton Ave., W., Toronto 9, Ont., Canada.

UNITED STATES AND POSSESSIONS

**Builders Exchange Co-operative,** Harvey S. Daley, Chairman, House Committee, 317 Builders Exchange Bldg., Portland 4, Ore.

**Keller, Duane R.,** Research Engineer, U. S. Department of the Army, Materials Analysis Lab., Research Div., Ordnance Missiles Labs., Redstone Arsenal, Huntsville, Ala. For mail: 109 Scenic Dr., Huntsville, Ala.

**Kessler, Harold D.,** Supervisor, Metallurgical Div., Titanium Metals Corporation of America, Box 2138, Henderson, Nev.

**Richardson, James K.,** Chief, Mechanical Branch, U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo.

**Sprague, Roger A.,** Laboratory Head, International Paper Co., Container Div., Georgetown, S. C.

**Tellyer, Harry B., Jr.,** Vice-President, Tellyer Concrete Pipe Co., Box 1629, Albuquerque, N. Mex. [J]

**Tyson, Harry D.,** Chemist, Peoples Water and Gas Co., North Miami, Fla., For mail: 191 N. W. 98th St., Miami 38, Fla.

**Waits, James Kelley,** Head, Standards Dept., Joanna Cotton Mills Co., Joanna, S. C., For mail: Box 483, Joanna, S. C.

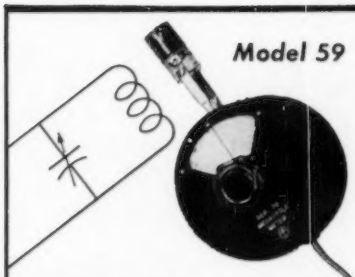
**Willett, Eugene P. H.,** Secretary-Treasurer, Dixie Laboratories, Inc., 201 Beauregard St., Mobile, Ala.

OTHER THAN U. S. POSSESSIONS

**Elevadores Atlas S. A.,** Luiz D. Villares, President, Caixa Postal No. 8167, São Paulo, S. P., Brazil.

**Kelvinator of Canada, Ltd.,** Edward J. Knight, Chief Engineer, 1152 Dundas St., Lonton, Ont., Canada.

(*Continued on page 82*)



Model 59

# MEGACYCLE METER

2.2 mc. to 400 mc.

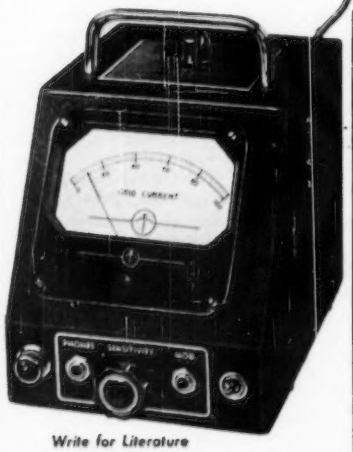
*Frequency Accuracy ±2%*

## The MULTI-PURPOSE INSTRUMENT

- For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, coils.
- For measuring capacitance, inductance, Q, mutual inductance.
- For preliminary tracking and alignment of receivers.
- As an auxiliary signal generator; modulated or unmodulated.
- For antenna tuning and transmitter neutralizing, power off.
- For locating parasitic circuits and spurious resonances.
- As a low sensitivity receiver for signal tracing.

*And Many Other Applications*

| FREQUENCY: | MODULATION: |
|---|---|
| 2.2 mc. to 400 mc., seven plug-in coils. | CW or 120 cycles, or external. |
| **POWER SUPPLY:** | **DIMENSIONS:** |
| 110-120 volts, 50-60 cycles; 20 watts. | Power Unit: 5⅛" wide, 6⅛" high, 7½" deep. Oscillator Unit: 3¾" diameter, 2" deep. |



*Write for Literature*

**MEASUREMENTS CORPORATION**

BOONTON NEW JERSEY

ACCO products

# Wilson "Rockwell"* Hardness Testers

## Steel...soft metals or plastics... small parts or odd shapes... Wilson tests them all *quickly...accurately*

A FULL LINE TO MEET EVERY HARDNESS TESTING REQUIREMENT

FULLY AUTOMATIC
•
SEMI-AUTOMATIC
•
REGULAR
•
SPECIAL
•
SUPERFICIAL
•
TUKON
MICRO & MACRO

• Recognized as the leader, WILSON "ROCKWELL" Testers set the standards of hardness testing. In the laboratory or on the production line, wherever *exact* hardness must be checked, there is no substitute for WILSON.

Completeness of the WILSON line makes it unnecessary to compromise with makeshift testing methods. The WILSON organization is nation-wide. Our experts are available not only to help you select the exact tester best suited to your requirements but to consult with you on problems involving hardness tests.

Write for full information on WILSON "ROCKWELL" Hardness Testers, diamond Brale penetrators and accessories.

**Trademark Registered*

ACCO Wilson Mechanical Instrument Division

AMERICAN CHAIN & CABLE

230 C Park Avenue, New York 17, N. Y.

BRALE DIAMOND PENETRATORS AND ACCESSORIES

(*Continued from page 80*)

**Palomino Y Mora,** Carlos Palomino, Mechanical Engineer, Durango 167, Mexico D. F., 7, Mexico.

**Administracion General de Las Usinas,** Electricas y Telefonos del Estado, Seccion T. A. B., Biblioteca Tecnica, Paraguay 2431, 10º piso, Montevideo, Urugay.

**Barreda, J. Alberto,** Forester and Agronomist, Escuela Nacional Agricultura, Box 456, Lima, Peru.

**Beique, C.,** Technical Superintendent, The Arborite Co., Ltd., 385 Lafleur Ave., Ville LaSalle, Montreal 32, P. Q., Canada.

**Duarte, Bernardo Mora,** Assistant Soils Engineer, Winston-Mantilla-Montilla, Apartado Aereo 1068, Cartagena, Colombia.

**Fowler, Eldon Lloyd,** Manager, Materials Testing Laboratories, Ltd., 10214 112th St., Edmonton, Alta., Canada.

**Jones, Leo James,** Manager, The Queensland Cement and Lime Co., Ltd., Darra, Queensland, Australia.

**Lang, W. A.,** Secretary, Research Council of Canada, University of Alberta, Edmonton, Alta, Canada.

**Lundgren, Bengt,** Metallurgist, Aktiebolaget Svenska Kullagerfabriken, Box 1521, Göteborg 1, Sweden.

**Mazza, Mario J.,** Chief Chemist, Cia. Argentiana de Cemento Portland, Sierras Bayas, F. C. N. G. R., Argentina.

**Miyanaga, Kiichiro,** Chief Engineer, Toyo Koatsu Industries, Inc., Ofuna Kogyo-sho, Kasama-cho, Tozuka-ku, Yokohama-shi, Japan.

**Newby, George R.,** Welding Specialist, C. D. Howe Co., Ltd., 1421 Atwater Ave., Montreal 25, P. Q., Canada. For mail: 83 Eighth Ave., Ville LaSalle, Montreal 32, P. Q., Canada.

**Okada, Takuo,** Chief, Research Lab., Toyo Koatsu Industries, Inc., Omuta Kogyo-sho 8, Sanko-cho, Omuta-Shi, Fukuoka-ken, Japan.

**Rao S., Maruthi,** Production Inspector, Premier Automobiles, Ltd., Agra Rd., Kurla, Bombay, India. For mail: D. S. Chamdavarkar, 21/83 Kole Kalyan, Santa Cruz (East) Bombay 25, India. [J]

**Sehlberg, Gösta,** Chief Metallurgist, Degerfors Järnverks Aktiebolag, Degerfors, Sweden.

**Uttar Pradesh, Public Works Dept.,** Chief Engineer, Lucknow (U. P.) India.

**Wilkinson, Maxwell,** Chief Chemist, Holeproof, Ltd., Box 42, Brunswick, Melbourne, Australia.

*[J] denotes Junior members.

## Construction Review

*Construction Review* is the title of the consolidated publication formed by the merger of two Government publications on construction: the Commerce Department's monthly report, *Construction and Building Materials* and the Labor Department's monthly, *Construction.*

The joint publication brings together nearly all the current construction statistics compiled by the Federal Government. In addition to some information from nongovernmental sources, articles on specific aspects of construction trends and activity are included.

*Construction Review* is available at $3 (12 issues) or 30 cents a copy from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., or from field offices of the Department of Commerce.

# DEATHS...

**Earl R. Bryant,** Technical Service Director, Universal Atlas Cement Co., New York, N. Y. (January 26, 1955). Member since 1953, and representative of his company on Committee C-9 on Concrete and Concrete Aggregates, and its Subcommittees on Durability of Concrete, and Methods of Testing and Specifications for Lightweight Aggregates for Concrete; also member of Committee CM-15 on Manufactured Masonry Units. Associated with the Universal Atlas Co. since 1941, he previously had served for eleven years as Cement Inspector and Materials Engineer with the Missouri State Highway Department. His other society affiliations include the American Concrete Inst., American Railway Engineers Assn., Highway Research Board, and the Concrete Industries Board of New York City.

**E. W. Davis,** Director of Engineering, Simplex Wire & Cable Co., Cambridge, Mass. (January 11, 1955). Representative of his company since 1940 on Committee B-1 on Wires for Electrical Conductors. He also had served on ASA Sectional Committee H-4 on Copper Wire from 1940 until 1950 when the committee was discontinued.

**N. K. Dickerson, Sr.,** Contractor, Dickerson, Inc., Monroe, N. C. Member since 1950.

**Ronald S. Drysdale,** special representative in charge of metalworking and cutting oils for the Sun Oil Co. since 1920, died February 20, 1955, at his home in Prospect Park, Pa., at the age of 72. Born in Wales, Mr. Drysdale was a graduate of the University of London, and had taken postgraduate work at Tufts College. He had represented his company since 1947 on Technical Committee K on Cutting Fluids of Committee D-2 on Petroleum Products and Lubricants.

**L. R. Eastman,** Manager, Composition Dept., Frederic B. Stevens, Inc., Detroit, Mich. Representative of company in the Society since 1943, and on Committee B-8 on Electrodeposited Metallic Coatings.

**D. S. Geary,** Manager, Queensland Cement and Lime Co., Ltd., Darra, Brisbane, Australia (January 2, 1955). Member since 1945.

**Alfred Hollis Geisler,** Research Associate, Metallurgy Dept., General Electric Research Laboratory, Schenectady, N. Y. (December 7, 1954). Representative of company since 1952 on Committee E-4 on Metallography. A 1938 graduate of Carnegie Institute of Technology, receiving a D.Sc. in 1942, Dr. Geisler died after a brief illness at the age of 38 years. His work as a physical metallurgist was widely recognized in the fields of alloy transformations, X-ray and neutron diffraction, metallography and electron microscopy. He authored more than 35 technical papers, one of which won an AIME Mathewson Award as the outstanding Institute of Metals Division paper in 1943. His society affiliations included the American Institute of Mining and Metallurgical Engineers, American Society for Metals, and the American Crystallographic Assn.

**Henry W. Herbst,** President, Biwax Corp., Skokie, Ill. (1954). Member since 1952, and active in Committee D-9 on Electrical Insulating Materials and its Subcommittee VI on Solid Filling and Treating Compounds.

**Raymond G. Osborne,** Testing Engineer, Raymond G. Osborne Testing Laboratories, Los Angeles, Calif. Member since 1907; member of Southern California District Council from 1940 to 1951.

**T. S. Quinn,** cofounder and Treasurer, Lebanon Steel Foundry, Lebanon, Pa. (February 20, 1955). Member of the Society since 1932, and for some time active in Committees A-1 on Steel and A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, representing the Steel Founders' Society of America.

**B. S. Reid,** International Brotherhood of Electrical Workers, East St. Louis, Ill. (October 30, 1954). Representative of Brotherhood since 1948 on Subcommittee IV on Protective Equipment for Electrical Workers of Committee D-11 on Rubber and Rubber-Like Materials; also member of ASA Sectional Committee J6 on Specifications for Protective Equipment for Electrical Workers, representing the U. S. Department of Labor, Bureau of Labor Standards.

**Clarence C. Ruchhoft,** noted scientist and engineer with the U. S. Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnnati, Ohio, until his retirement due to illness July 1, 1954, died January 19, 1955. Mr. Ruchhoft had been a member of the following ASTM committees for a number of years: D-19 on Industrial Water and its Subcommittee on Industrial Waste Water; and E-10 on Radioactive Isotopes. A 1921 graduate of the University of Minnesota, Mr. Ruchhoft was an authority on the disposal of radioactive wastes, serving as consultant to the Atomic Energy Commission and the Committee on Radiation Protection of the National Bureau of Standards. He had been a consultant to the U. S. Army, Air Force, and Navy. He was a member of the Society of American Bacteriologists, American Water Works Assn., Central Sewage Works Assn., and the Engineering Society of Cincinnati.

**Harry O. Schuessler,** Vice-President and General Manager, Apollo Metal Works, Chicago, Ill. (December 22, 1954). Member since 1929.

**Willard I. Upson,** Director, Analytical Chemists of Cincinnati, Cincinnati, Ohio (October, 1954). Member since 1941.

**Isaac Van Trump,** Consulting Paving Engineer and Chemist, Chicago, Ill. (February 8, 1954). Member since 1909.

# CSI RESEARCH DEVELOPMENT QUALITY CONTROL INSTRUMENTS

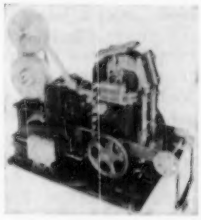
**A—THICKNESS-COMPRESSION-RECOVERY**

The C & R Tester is a versatile instrument for thickness measurements by a selection of pressure feet. (ASTM design. D 39, D 76, D 347, D 412, D 461, D 577 and D 645). Compression and recovery thickness are measured by applying a dead load without impact by means of a handwheel.

A

**B—ABRASION**

The Armstrong Abrader was designed to obtain quantitative measure of the resistance of sheet (rigid or semi-rigid) compositions to the abrasive action of sandpaper. (ASTM design. D 1242-52 T, Procedure 3).



B

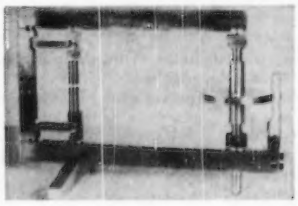
**C—TEXTILES**

The Celanese Wrinkle Tester, is a helpful tool in evaluating the resilience and wrinkle behavior of fabrics under conditions very similar to those occurring in actual use.

C

**D—INSPECTION**

The CSI Templin Calibrator was designed to meet the need for a precision checking instrument for extensometers, strain gages, dial gages and test indicators, which would be precise, simple to operate and readily portable (ASTM design E 83-52 T).



D

**E—BIO-CHEMICAL**

The CSI Dry Ice Storage Cabinet built for storing vaccines, viruses, drugs and other biologicals and pharmaceuticals requiring very low temperature for preservation. (-60°C)

E

**CUSTOM SCIENTIFIC INSTRUMENTS, INC.**
541 Devon Street Kearney, N. J.
*Mfg. of Custom-Built Lab. Equipment*

# A NEW Weather-Ometer®

## . . . for Weather Testing of Plastic and Rubber Products

**MODEL DMC**

**Greater accuracy and reproducibility achieved with new modulated temperature control.**

Accuracy in test results is greatly increased in the new DMC Weather-Ometer by a positive control of specimen temperatures.

A constant volume of air at a controlled temperature in the heavily insulated cabinet, maintains uniform predetermined specimen temperatures regardless of variations in room conditions.

Automatic control of humidities up to dew point is available as optional equipment.

All automatic controls including complete voltage controls are located on the front panel of the Weather-Ometer directly above the door of the test chamber.

Both horizontal and vertical testing is available. Shallow containers are used for semi-liquid materials and vertical panels for solid materials.

Source of radiation is two Atlas enclosed violet carbon arcs.

Complete technical information on the DMC model and other Weather-Ometers is contained in the new Weather-Ometer catalog. A copy will be mailed on request.

**ATLAS ELECTRIC DEVICES CO.**
4114 N. Ravenswood Ave., Chicago 13, Illinois
*Manufacturers of accelerated testing equipment for over a quarter of a century.*

WEATHER-OMETERS • FADE-OMETERS • LAUNDER-OMETERS

Eberbach

**POWER STIRRER WITH ELECTRIC GOVERNOR**

New Eberbach POWER-STIR with Electric Governor is a high-torque, variable speed stirrer designed for intermittent medium duty. The governor maintains desired speed despite line voltage fluctuations or load variations. Important feature too is the Eberbach exclusive "Hollow Spindle." This device not only holds and centers metal, glass or plastic stirring rods, but also permits the operator to vary the working length of the agitator by simply sliding it up or down.

**Model 77-836D**
**$50.00**

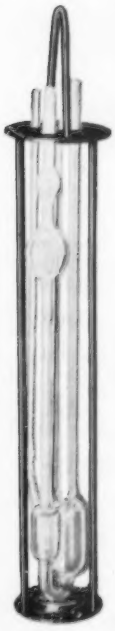
ADVANTAGES

- Maintained Speed
- Hollow Spindle
- 200 to 1000 R.P.M.
- Extra High Torque

Just clip this ad to your letterhead stationery. We'll send you full details on this exciting new stirrer.

Eberbach CORPORATION
ANN ARBOR, MICH.
SCIENTIFIC INSTRUMENTS & APPARATUS





**UBBELOHDE**
**VISCOSIMETER**
on the Principle of the Suspended Level

For the determination of the kinematic viscosity of any true viscous liquid, such as petroleum products or lubricants.

See: American Society for Testing Materials. ASTM Designation: D 445–46 T

This capillary-type viscosimeter measures viscosity—under proper manipulation—with an error not greater than ±0.1%, when used at efflux times of 80–1000 seconds, or preferably 100–700 seconds. The smallest listed capillary is used for light fuel oil or kerosene, the others for lubricating oils. The temperature of the bath should be controlled within ±0.02° F.

Available in all capillary sizes as called for by the ASTM—calibrated or uncalibrated.

**NEW, LOWER PRICES**

| | |
|---|---|
| Uncalibrated Capillary..... | $18.00 Each |
| Calibrated Capillary..... | 37.50 Each |
| Metal Frame to Fit Capillary .. | 6.00 Each |

*Bulletin UV349 will be sent on request.*

Order direct or from leading laboratory supply dealers

FISH-SCHURMAN CORPORATION
78 Portman Road, New Rochelle, N. Y.

Fish-Schurman


## CALENDAR OF OTHER SOCIETIES' MEETINGS

April 4–7—**American Chemical Society,** Division of Paint, Plastics, and Printing Ink Chemistry, Cincinnati, Ohio.

April 5–6—**AIEE,** Rubber and Plastics Conference, Akron, Ohio.

April 5–7—**National Fluid Power Assn.,** Annual Spring Meeting, Colorado Springs, Colo.

April 6–10—**World Plastics and Trade Exposition,** National Guard Armory in Exposition Park, Los Angeles, Calif.

April 7–8—**Malleable Founders' Society,** Market Development Conference, Edgewater Beach Hotel, Chicago, Ill.

April 11–13—**American Crystallographic Assn.,** Symposium on X-ray Crystallography, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

April 13–15—**Natural Gasoline Association of America,** Annual Convention, Baker and Adolphus Hotels, Dallas, Tex.

April 14–15—**Illuminating Engineering Society,** South Pacific Coast, Statler Hotel, Los Angeles, Calif.

April 15–16—**American Society of Heating and Air-Conditioning Engineers,** Regional Meeting, Oklahoma City, Okla.

April 18–19—**Third National Air Pollution Symposium,** Pasadena, Calif.

April 18–20—**American Oil Chemists' Society,** Spring Meeting, New Orleans, La.

April 18–21—**Building Officials Conference of America, Inc.,** Fortieth Annual Convention, Schroeder Hotel, Milwaukee, Wis.

April 18–21—**American Society of Mechanical Engineers,** Spring Meeting, Baltimore, Md.

April 18–21—**AMA,** National Packaging Exposition, International Amphitheater, Chicago, Ill.

April 18–21—**Society of Automotive Engineers, Inc.,** National Meeting, Golden Anniversary Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Statler and McAlpin Hotel, New York, N. Y.

April 19–21—**Canadian Institute of Mining and Metallurgy,** Annual Meeting, Royal York Hotel, Toronto, Canada.

April 25–26—**ASME,** Instruments and Industrial Regulators Division Conference, University of Michigan.

April 27–29—**Society for Experimental Stress Analysis,** Spring Meeting, Hotel Statler, Los Angeles, Calif.

May 1–4—**American Institute of Chemical Engineers,** Shamrock Hotel, Houston, Tex.

May 1–4—**Liquefied Petroleum Gas Assn.,** Annual Convention, Conrad Hilton Hotel, Chicago, Ill.

May 2–5—**The Electrochemical Society, Inc.,** Sheraton-Gibson Hotel, Cincinnati, Ohio.

May 3–8—**International Oil Exposition,** Houston Coliseum, Houston, Tex.

May 4–7—**National Screw Machine Products Assn.,** Annual Meeting, Statler Hotel, Buffalo, N. Y.

May 5–6—**Society of American Military Engineers,** 1955 Annual Meeting, Waldorf-Astoria, New York, N. Y.

May 6—**American Assn. of Spectrographers,** Sixth Annual Conference, Chicago, Ill.

May 7–15—**Society of the Plastics Industry, Inc.,** SPI Annual Meeting and Conference, Cruise on the Queen of Bermuda.

May 9–12—**American Petroleum Institute,** Division of Refining Mid-Year Meeting, Jefferson Hotel, St. Louis, Mo.

May 10–11—**AIEE,** Electric Heating Conference, La Salle Hotel, Chicago, Ill.

May 10–12—**Metal Power Assn.,** Show, Philadelphia, Pa.

May 12–13—**Society for Applied Spectroscopy,** Annual Meeting, Hotel New Yorker, New York, N. Y.

May 16–19—**American Mining Congress,** Coal Show, Public Auditorium, Cleveland, Ohio.

May 16–20—**Sixth National Materials Handling Exposition,** International Amphitheater, Chicago, Ill.

May 17–19—**Assn. of American Railroads,** Annual Session, St. Francis and Sir Francis Drake Hotels, San Francisco, Calif.

May 18–20—**AIEE,** Telemetering Conference, Morrison Hotel, Chicago, Ill.

May 18–21—**Pulp and Paper Industry,** Third Western International Meeting, Empress Hotel, Victoria, B. C.

May 23–27—**American Foundrymen's Society,** 59th Annual Convention, non-exhibit, Houston, Tex.

May 31–June 2—**Chemical Institute of Canada,** Quebec City, Quebec.

May 31–June 3—**Third Basic Materials Exposition,** Convention Hall, Philadelphia, Pa.

June 12–17—**SAE,** National Meeting, Golden Anniversary Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

YOU GET

# EXTRA VALUE IN Mallinckrodt AR's

ANALYTICAL REAGENTS

**YOU GET EXTRA VALUE IN PURITY**

Mallinckrodt's careful selection of raw materials, utmost care in manufacturing processes, and detailed analytical tests assure *outstanding purity of all* Mallinckrodt AR's.

**YOU GET EXTRA VALUE IN SERVICE**

Eighty-five responsible AR dealers in fifty-nine cities employ over 500 trained specialists. These dealers carry ample stocks of Mallinckrodt AR's and are always ready for prompt and efficient service.

**YOU GET EXTRA VALUE IN PACKAGING**

Most Mallinckrodt AR's are packaged in *space-saving* STORMOR bottles.

REMEMBER TO SPECIFY
AND INSIST UPON

Mallinckrodt AR's

in STORMORs

**MALLINCKRODT CHEMICAL WORKS**

SECOND AND MALLINCKRODT STREETS, ST. LOUIS 7, MO.

72 GOLD ST., NEW YORK 8, N. Y. • CHICAGO • CINCINNATI • CLEVELAND

LOS ANGELES • PHILADELPHIA • SAN FRANCISCO • MONTREAL • TORONTO

Compare, for example,

**CALCIUM CHLORIDE ANHYDROUS AR**

This is another of the many Mallinckrodt analytical reagents controlled for purity within American Chemical Society tolerances. Five mesh sizes are available to satisfy your analytical needs—4, 8, 12, 20 and 40 mesh.

The large exposed surface area of the particles affords maximum efficiency in moisture absorption. This makes Mallinckrodt Calcium Chloride Anhydrous AR an excellent drying agent and moisture absorbent, in addition to its other analytical applications.

When you order Calcium Chloride for your laboratory, specify Mallinckrodt.

# NEWS NOTES ON
# Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses

## NEW PRODUCTS

**Polyethylene Bottles and Jars**—These bottles are especially important for applications where the elimination of permeability in handling inorganics is a factor.

**Weighing Bottles**—Designed to replace glass units, the polyethylene bottles, in addition to their nonbreakable feature, are also unaffected by caustic solutions and acids which often etch other types of containers.

*American Agile Corp., P. O. 168, Bedford, Ohio.*

**Stopwatch Support Fits the Hand**—To prevent damage to costly stop watches used in science and industry, due to handling with wet, dirty, oily, or greasy hands, a practical stop-watch holder is now available.

*Andrew Technical Supply Co., 6972 N. Clark St., Chicago 26, Ill.*

**Snubber Type Grips**—Grips designed to minimize or prevent breaks at the grips—for tensile strength tests of wire up to 0.06 in. diameter.

*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

**Portable Controlled Temperature Cabinet**—Testing temperatures ranging from −100 F to 400 F are made possible by a new portable controlled-temperature cabinet designed for testing machines of three capacities up to 400,000 lb.

**Extensometer**—A nonaveraging, screw-on separable miniature variable transformer for use on ½-in. wide flat specimens 0.005 to 0.250 in. thick with 2-in. gage length.

*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

**Silicon Rectifiers**—Outstanding among the characteristics of the new high-current, high-voltage silicon power rectifier is its efficiency of approximately 99 per cent and its ability to operate in extremely high ambient temperatures.

*Bogue Electric Manufacturing Co., Paterson, N. J.*

**Digital Cycling Counter**—A five-bank digital cycling counter, suitable for counting events, measuring frequencies, determining RPM, and other similar basic measurements applications.

*Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

**Specimen Mounting Press**—Design features include automatic temperature control, center ejection of the completed specimen, and the possibility of using both 1-in. and 1¼—in. specimen molds with the same heater and cooler.

**Polishing Tables**—A streamlined all-metal polishing desk in single, two or three unit models.

*Buehler Ltd., 2120 Greenwood St., Evanston, Ill.*

**New Clamp**—A new clamp, designed to hold rubber stoppers firmly in place in five-gallon or other size bottles that take a 2½-in. stopper.

*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*

**Scale Monitor**—An electronic device by which weight or force may be read at a distance.

*John Chatillon & Sons, 85 to 93 Cliff St., New York 38, N, Y.*

**Air Blast Pressure Gages**—Barium titanate air blast gages were developed for precise measurement of transient pressures of shock waves in air as well as in other gases and liquids.

*Chesapeake Instrument Corp., Shadyside, Md.*

**Vacuum Gage**—A new, single-station thermocouple gage with printed circuit is calibrated for air with one direct reading meter scale covering the range from 1 to 1000 microns mercury.

*Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

**Conductive Lubricant**—Highly conductive top-grade lubricant designed for use in conducting hinge joint switches.

*Cool Amp Co., 8603 S. W. 17th Ave., Portland 19, Ore.*

**Terminal Blocks**—Combination of a Curtis "FTLP" (Feed-thru Long Pin) Terminal Block and a Curtis "RH" Block offers three unusual advantages beyond the conventional type of multi-contact plug-in: solderless anchoring of each individual connector, convenient identification of circuits, and a very simple means of making any number of multiple contacts.

*R. E. Miller, Curtis Development & Manufacturing Co., 3266 N. 33rd St., Milwaukee 16, Wis.*

**Tensiometer**—For the measurement and proper regulation of yarn tension in the textile industry.

*Custom Scientific Instruments, Inc., Arlington, N. J.*

**Dyna-Switch**—Purpose of the 20,000-lb Dyna-Switch is to prevent overload damage to costly hoisting equipment by automatically cutting out lifting power whenever the safety maximum is exceeded.

*W. C. Dillon & Co., Inc., P. O. Box 3008, Van Nuys, Calif.*

**Camera**—A new 35mm miniature camera which is expected to be of particular interest to industrial photographers features interchangeable lens components, built-in exposure meter, a combined range-finder-viewfinder, and coordinated shutter and diaphragm controls which are expected to make it particularly adaptable to use in the field as well as in the laboratory.

*Eastman Kodak Co., Rochester 4, N. Y.*

**Two-Foot Furniture Unit**—A drawer-cupboard unit only two feet wide fits easily into the left-over space at the end of bench assemblies or any other "tight" installation, can be squeezed in to take up nonutilized slack.

**Recordall**—A universal laboratory recorder which records any operation that produces a change in potential, current, or resistance.

*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Potentiometers**—Eight different models with power ratings ranging from 2 to 20 w at 40 C ambient, and 17 stock-resistance values covering the range from 2 to 500,000 ohms.

*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

**Syte-Ayde**—Accuracy of production and inspection procedures is increased, work is speeded and simplified by the G-s Syte-Ayde which provides light in out-of-the-way places. It is unexcelled for critical seeing tasks.

*General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32, Pa.*

**32 Pole DC Relay**—Originally designed as a "group" relay, a new Series 805 Relay is capable of simultaneously connecting together 32 electrical circuits.

*Guardian Electric Mfg. Co., Chicago 11, Ill.*

**Duodial**—The SR series Duodial turns-counting dial designed for use with any rotating component having a ¼-in. diameter shaft.

*Helipot Corp., 916 Meridian Ave., South Pasadena, Calif.*

**Sub-Miniature Relay**—Maximum space conservation in a relay of high-performance characteristics is achieved in a new sub-miniature, 2-pole design.

*Hi-G Inc., Windsor Locks, Conn.*

**Portable Wheastone Bridges**—Portable Wheatstone Bridges as completely gasketed units eliminate infiltration of wire or other metal particles to switch assemblies.

*Industrial Instruments, Inc., Cedar Grove, N. J.*

**Microvoltmeter-Amplifier**—A new d-c Model 202, which is noteworthy for high input impedance, high sensitivity, high stability, instant polarity indication, and stable zero.
*Kay Lab, 1090 Morena Blvd., San Diego, Calif.*

**Table Model Universal Testing Instrument**—Compact, sensitive instrument records with electronic accuracy stress-strain curves under tension or compression.
*Instron Engineering Corp., 440 Hancock St., Quincy, Mass.*

**Floor Armor**—Announcement of a new Hexteel safety floor armor that has less weight per square foot and a greater exposed steel surface to create the most durable floor ever designed for abnormal wear and rough usage.
*Klemp Metal Grating Corp., 6603 S. Melvina Ave., Chicago 38, Ill.*

**Constant-Temperature Bath**—Originally developed for Turbine Oil Oxidation Test (ASTM D 943), it can also be used for Kinematic Test (ASTM D 445), Transformer Oil Oxidation Tests, and all types of constant temperature work requiring temperatures up to 100 C and sensitivity of control to ±0.01 C.
*Labline, Inc., 217–221 N. Des Plaines St., Chicago 6, Ill.*

**Constrained Bridge Magnetic Amplifier**—Noteworthy for high power efficiency, very low quiescent power consumption and freedom from zero drift due to change in rectifier characteristics.
*Librascope, Inc., 808 Western Ave., Glendale, Calif.*

**Friction**—Machine for friction testing of materials under load, such as brake linings, that embodies several new concepts in testing and machine design.
*Link Engineering Co., Detroit, Mich.*

**Decade Scaler for Measuring Radioactivity**—Designed for use with Geiger-Müller or scintillation detectors, Model 181 decade scaler has five microsecond resolving time, permitting extremely precise measurements of radioactivity.
*Nuclear-Chicago, 229 W. Erie St., Chicago 10, Ill.*

**Torsion Tester**—A 200,000-in. torsion testing machine which loads and indicates torque in both directions of rotation.

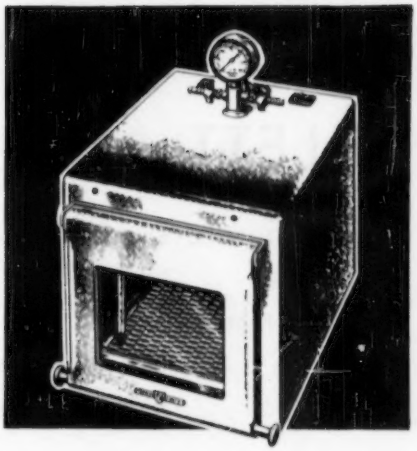
**Soil Tester**—Consolidation tests on soil samples can be conducted with greater ease, control, and accuracy with the new Conbel physical soil testing machine.
*Tinius Olsen Testing Machine Co., 3073 Easton Road, Willow Grove, Pa.*

**Long-Tip Pipe**—Developed for easy insertion into apparatus with narrow openings, it is useful for delivery of or removing fluids from small volumetric flasks, Warburg flasks, absorption cells, and microcentrifuge tubes.
*Owens-Illinois Glass Co., Toledo, Ohio.*

**Volumetric Flask**—New and improved Cassia volumetric flask has a larger body and more accurate neck than previously manufactured.

*(Continued on page 88)*


all the features you need for fast, safe drying...



yet **PRECISION** *Thelco*

**VACUUM OVENS**
**COST LESS TO OWN AND OPERATE**

**Twice as Fast as Drying at Atmospheric Pressure**

**Minimum Oxidation of the Sample**

**No Scorching or Charring—Even at Fast Drying Rates**

**Safer—Flammable Gases Drawn Off**

**Also Can Be Used for Desiccation of Foods and Conditioning**

Quality and performance don't necessarily carry a big price tag. A good example of this is Precision-Thelco Vacuum Ovens. They bring all of the advantages of vacuum drying to research laboratories—are built to give long service without expensive heater replacements, new door seals or other repairs, yet are moderately priced. Compare the features below with any other vacuum oven and you'll see why Precision-Thelco is your best buy for the money.

**WIDE AREA HEATER**—Operates at black heat, not incandescence, for greater safety and longer life.

**ACCURATE HYDRAULIC THERMOSTAT**—Automatically maintains constant temperature from 5° above room temperature to 125°C. May be easily re-set.

**THICK PYREX GLASS WINDOW**—Allows complete visibility of all parts of oven while in operation. Permits observing samples without opening door.

**POLYACRYLIC GASKETED DOOR**—Makes air-tight seal when vacuum is applied. Stays soft and supple even at extreme temperatures. For easier loading, door stays up when completely raised.

**RECTANGULAR SHAPE**—Gives maximum operating capacity with most efficient use of lab space. Vacuum gage mounted on top for easy reading.

**GLASS WOOL INSULATION**—Won't deteriorate or absorb moisture.

**ATTRACTIVE FINISH**—"Silver-Tone" Hammerloid—a tough, baked-on enamel—harmonizes with other laboratory equipment.

Write for additional details in Catalog No. 331A.

Precision Scientific Company

3751 WEST CORTLAND STREET • CHICAGO 47

KLETT MADE

Colorimeters

Visual

Photo-Electric

Special Types For Testing

Colors Petroleum Products

Glass Color Standards

Glass Cells

Fluorimeter

Nephelometer

Complete Electrophoresis Equipment

**KLETT MANUFACTURING COMPANY**

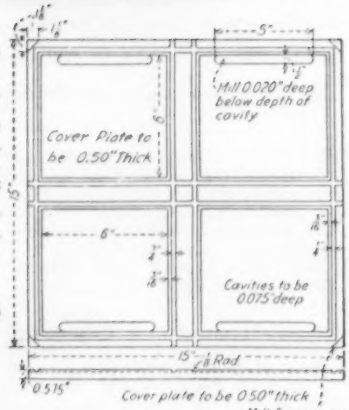
*Manufacturers of Scientific Instruments*

179 East 87th Street New York 28, N. Y.



MOLDS AND DIES — HOGGSON BRAND Since 1849 — FOR RUBBER TESTING

Single and multi-cavity molds made to order for making samples for testing adhesion, abrasion, flexing, compression, rebound. Years of experience in rubber. Prompt service.


Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
Cavities to be 0.075" deep
Cover plate to be 0.50" thick
Mill four corners ⅛ deep for prying mold apart

1" and 2" Centers

Standard ASTM and Federal dies for cutting test tensile and tear strength samples and dies for Slab curing carried in stock. Write for catalog.

**HOGGSON & PETTIS MANUFACTURING CO.**

133 Brewery St.

NEW HAVEN 7, CONN.

Pac. Coast H. M. Royal, Inc., Los Angeles


(*Continued from page 87*)

**Stirrer**—A new, improved type of stirrer, utilizing a direct drive and 1/50-hp motor, rheostat speed control, together with double housing for extra fume protection.

*Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.*

**Mobile Bench Unit**—The Rolla-bench, a mobile unit that rolls along the bench on guide rails, adds five sq ft of extra working space wherever and whenever it is needed.

**Dual Titrometer.**—Originally intended for the determination of acidity in lubricants, the Dual Titrometer is applicable to a wide range of other opaque and highly colored solutions where the usual color indicator titrations are not practical.

*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

**Titration Stand**—A redesigned titration stand which provides soft, evenly diffused "daylight" illumination for both the titration burets and flasks features the use of the "full-View" buret clamp.

**Identifies Recording Charts**—Compact device that automatically prints a number, date, or time on strip chart and similar recorder charts at any instant when a voltage is applied to the device during process, test, and control work.

*Royson Engineering, Hatboro, Pa.*

**Microsplitter**—A specially designed Jones type riffle used for mixing fine-grained materials and obtaining homogeneous splits and microsamples.

*Sepor Microsplitter Supply, 1545 S. Oak Park Ave., Berwyn, Ill.*

**Conduit**—Flexible-metal, electrical wiring conduit is fully enclosed in a tough, waterproof, synthetic cover.

*Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill.*

**Ovens for Crystals**—Compact temperature-controlled ovens for use with JAN type HC-6/U and HC-13/U crystals.

*Valpey Crystal Corp., 1244 Highland St., Holliston, Mass.*

## CATALOGS AND LITERATURE

**Recording Equipment**—Methods of recording all types of instrumentation information such as vibration, shock, sound, pressure, and telemetering data, etc., from 100 to 100,000 cps are described in *Bulletin 103.*

*A-V Manufacturing Corp., 730 Fifth Ave., New York 19, N. Y.*

**AB Metal Digest**—Buehler, Ltd. has produced the first issue of a new bi-monthly publication, the *AB Metal Digest,* which contains articles on new developments in metallurgy and new items of metallurgical equipment.

*Buehler, Ltd., 2120 Greenwood St., Evanston, Ill.*

**Cenco News Chats**—A new issue of *Cenco News Chats,* No. 80, features the importance of instrument selection in education and research.

*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*

**Labwasher**—*Bulletin 55* describes Labwasher for the automatic washing and drying of laboratory glassware which features manual control which permits altering the standard cycle of operation and thermostat to insure proper water temperature.

*The Chemical Rubber Co., 2310 Superior Ave., Cleveland 14, Ohio.*

**Specialized Development**—*Specialized Development* is the title of a piece of literature which will be of special interest to manufacturers having a problem of electrical or mechanical controls and components.

*R. E. Miller, Sales, Curtis Development & Mfg. Co., 3266 N. 33rd St., Milwaukee 16, Wis.*

**Filter Facts**—The first of a series of papers based on factual engineering data concerning filter facts.

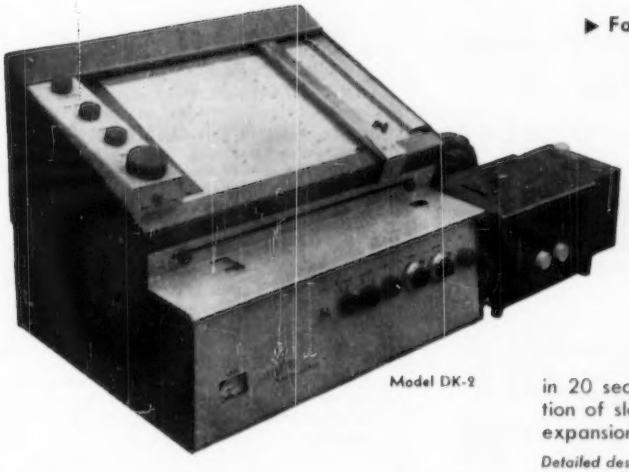
*Engine Life Products Corp., El Monte, Calif.*

**Indicating Temperature Controller**—Performance specifications, application ideas, and a complete description of a new liquid-filled, remote indicating temperature controller are presented in a two-color brochure.

*Fenwal Inc., Ashland, Mass.*

BECKMAN MODEL DK-2

# RECORDING SPECTROPHOTOMETER



Model DK-2

▶ For automatic recording of linear density and percent-transmittance in the range 220 to 2850 mmu

Utilizes a quartz monochromator with lead sulfide and photomultiplier detectors to provide high resolution. A new Beckman multi-speed recorder permits rapid and continuous recording of either percent-transmittance or linear density.

Records are made on fixed flat charts 11 X 17 inches in size.

Highest scanning speed covers the visible range in 20 seconds and near-infrared in 40 seconds. Permits selection of slow speeds for maximum resolution and selection of scale expansion with factors of 1, 2, 4 or 8.

*Detailed descriptive bulletin, recommendations as to application, etc., sent upon request.*

**Complete Assembly (Beckman 12900)**, as shown in illustration ..... 7,475.00

NOTE—Model DK-2 is also available as Beckman 12901 at $5,946.00 to users already supplied with Model DU but who require a recording instrument and who return the Model DU—less light source, power supplies and cells—in good condition as a "trade-in".

**ARTHUR H. THOMAS COMPANY**

*Laboratory Apparatus and Reagents*

WEST WASHINGTON SQUARE PHILADELPHIA 5, PA.

Teletype Services: Western Union WUX and Bell System PH-72

**Spectroscopy**—Announced in *Spectracord Bulletin FS-245* as the fastest recording-spectrophotometer commercially available, the Spectracord expedites product control, and releases professional personnel for more productive laboratory work.

**Electrodeposition**—Twelve fully illustrated pages in *Bulletin FS-250* show why laboratory analysis via electrodeposition of elements is (1) accurate, (2) specific, (3) timesaving, and (4) convenient.

**Isotemp Bath**—A new four-page (reading time: 5 minutes) *Bulletin FS-211* explains the reasons behind the development of a high-sensitivity constant temperature bath, its theory and operation.

**Titration**—*Titration Bulletin*, 16 pages, illustrated, shows why titration-by-instrumentation has made volumetric analysis the fastest, surest, and most convenient means of chemical control.

*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Paint Mill**—*Newsletter No. 8* describes the "Quickie" Paint Mill and the new Superjet Electric Spraying Kit.

*Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.*

**New Catalog**—Among the many new items listed are a wireless intercommunication system and a wide variety of plastic drawer cabinets.

*General Industrial Co., 5725 N. Elston, Chicago 30, Ill.*

**Durometers and Control.**—Instruments specifically designed to increase the quality, reproducibility, and therefore your confidence in the testing of rubber by durometer.

*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

**Micro-Hardness Tester**—Forty-eight page brochure, *Theory & Practice with the Reichert Micro-Hardness Tester*, will be forwarded on request.

*William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.*

**Fluid Control Valves**—Needle valves, toggle valves, Hi-Duty plug type valves, and packless diaphragm valves are all included in *Bulletin 3037*.

*Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.*

**Constant Temperature Rooms**—For operation from 40 to 140 F in sizes from 4 to 8 ft deep. *Bulletin No. 704A*.

*Labline, Inc., 217–221 N. Des Plaines St., Chicago 6, Ill.*

**Laboratory Apparatus**—*Lanco Apparatus Review No. 5* describes and illustrates 1954's best sellers in the line of laboratory apparatus, including polyethylene and stainless steel labware.

*Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.*

**Speedomax Instruments**—Complete information about new "Speedomax" Type H Indicators, Recorders, and Controllers is now available in a series of five data sheets, *N D46–33 (100) to (104)*.

*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

**Subminiature Switch**—Twelve-page *Catalog No. 75* covering subminiature snap-action precision switches, auxiliary actuators, subminiature switches, toggle and push-button subminiature switch assemblies.

*Micro Switch, Freeport, Ill.*

**Decontamination Safety Suits**—These suits offer protection against nitrobenzene, nitrotoluene compounds, aniline, and light concentrations of acids—fully described and cataloged in *Bulletin No. 1301 2*.

*Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.*

**Vacuum Pump**—A quick but comprehensive view of complete line of high vacuum pumps in four-page, two-color, *Bulletin V-54*.

**Vacuum Pump**—*Catalog No. 400*, a four-page, two-color bulletin, describes the advantages of the two-stage construction of the new Kinney Model KMB mechanical booster high vacuum pumps.

*Kinney Manufacturing Div., The New York Air Brake Co., Boston 30, Mass.*

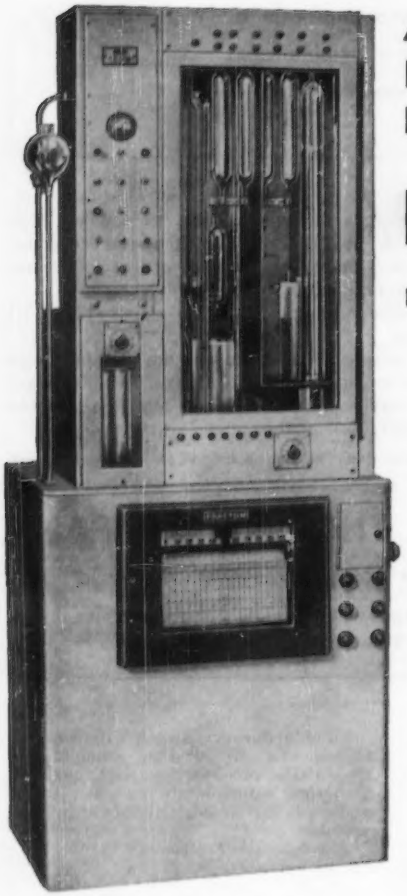
**Lubrication of Electric Motors**—*Bulletin No. 504* fully describes proper methods for lubricating and cleaning ball and roller bearings on electric motors.

*New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.*

*(Continued on page 90)*

BURRELL "For Scientists Everywhere"

presents THE FRACTON®



A New Instrument For Analysis of Light Hydrocarbons

2 to 3 Times Faster!

For:

NATURAL GAS

GASOLINE PLANT GASES AND LIQUIDS

REFINERY GASES

CYCLING PLANT GASES

LIQUEFIED PETROLEUM GASES

SYNTHETIC RUBBER INTERMEDIATES

PLASTIC INTERMEDIATES

PETROCHEMICAL GASES

*and other light hydrocarbons*

**THE FRACTON CUTS ANALYSIS TIME AND EXPENSE, IMPROVES ACCURACY AND IS EASIER TO OPERATE**

*Request your Copy of FRACTON BOOKLET No. 82*

The Fracton separates, identifies, collects and measures the components and records the analytical data in fifty to seventy-five percent less time than former methods. Users get superior accuracy and reproducibility with this new improved and simplified instrument.

® TRADEMARK

**BURRELL CORPORATION**

**2223 FIFTH AVENUE, PITTSBURGH 19, PENNSYLVANIA**

Manufacturers and Distributors of

SCIENTIFIC APPARATUS and LABORATORY CHEMICALS

*(Continued from page 89)*

**Polyethylene**—What you should know about polyethylene, *Catalog B954.*
*Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.*

**CPS Teflon Cloth**—Data on "CPS," the "Controlled-Pore Size" filter cloth of "Teflon" for corrosive liquid and gas filtration are compiled in *Bulletin T-112.*
*Porous Plastic Filter Co., 30 Sea Cliff Ave., Glen Cove, N. Y.*

**Maintenance Equipment**—Catalog featuring steel shelving, lockers, as well as other storage and maintenance equipment for industrial and institutional use.
*Precision Equipment Co., 3638 N. Milwaukee Ave., Chicago 41, Ill.*

**Water Washout Grease Tester**—An apparatus for evaluating the resistance of lubricating greases in a rotating bearing to washout by water is discussed in *Data Sheet No. 11498.*

**Vacuum Regulator**—*Data Sheet No. 10866R* on the Micro-Set Manostat, an instrument for regulating and holding a constant vacuum within 0.1 mm mercury pressure.
*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

**Height Gage**—A new and differently designed height gage uses a triangular scale beam for superior strength and exceptional rigidity, preventing sway and vibration.
*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

**Quality Control.**—Twenty-four page booklet on laboratory control, research, and development for the smaller American business—*Quality Control and Research.*
*Scientific Apparatus Makers Assn., 20 N. Wacker Drive, Chicago 6, Ill.*

**Induction-Heating Equipment**—An eight-page *Bulletin 85-871* describes a complete line of induction-heating equipment designed for operations such as hardening, annealing, brazing, forging, and heat-treating of metals.
*Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.*

## INSTRUMENT COMPANY NEWS

**Atlas Electric Devices Co.** has moved to its new plant located at 4114 N. Ravenswood Ave., Chicago 13, Ill.

**Burrell Corp., Pittsburgh, Pa.**—Burrell Corp. has been appointed exclusive distributor for Castor-Severs Extrusion Rheometers, instruments which measure the viscosity of coatings, adhesives, pastes, and plastisols under high-speed processing conditions.

**Burrell Corp., Pittsburgh, Pa.**—Lloyd V. Guild, with the firm since 1941 as research director, has been elected Vice-President in charge of research and product development for Burrell Corp., manufacturers and distributors of scientific apparatus and laboratory chemicals.

**Chicago Apparatus Co., Chicago, Ill.**—Charles Gramlich, formerly associate research chemist at the Portland Cement Assn. Research and Development Labs., has been appointed Technical Director of the Chicago Apparatus Co.

**Consolidated Engineering Corp., Pasadena 15, Calif.**—Francis T. Greenup appointed as chief design engineer of Consolidated Engineering Corp., Pasadena, Calif. will direct activities of a section responsible for new product design, engineering drafting, and operation of the Model Shop, where parts for model instruments are constructed for laboratory use.

**Consolidated Engineering Corp., Pasadena 15, Calif.**—Two major promotions in its technical services department were announced this week. C. William Bailey has been named manager of the Consolidated Engineering Corp. analytical service laboratory, and Robert C. Hoffman supervisor of application engineering as it relates to development and design of new analytical and control instruments.

**Leeds & Northrup Co., Philadelphia, Pa.**—G. Lupton Broomell, Jr., has been appointed chief engineer of Leeds & Northrup Co. Joining Leeds & Northrup in 1937, Broomell became successively head of the recorder development section, and assistant chief engineer.

**Arthur D. Little, Inc., Cambridge, Mass.**—Bruce S. Old. formerly President of Cambridge Corp., and more recently Chairman of the Board, has been appointed Vice-President in charge of the chemical and metallurgical division of Arthur D. Little, Inc.

**Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.**—R. A. Schlegel and J. F. Smith have been appointed associate sales managers for the oil and chemical industries for the Industrial Div. of Minneapolis-Honeywell Regulator Co.

**Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.**—Establishment of new sales and engineering offices in Phoenix, Charlotte, and Denver is announced by Micro Switch, a division of Minneapolis-Honeywell Regulator Co. Ralph C. Froehlich, formerly of Los Angeles, heads the new Phoenix office; Donald S. Schultz is being transferred from Philadelphia to take charge of the Charlotte office, and Richard J. Petersen, formerly of Minneapolis, is in charge of sales and engineering in the Denver area.

**Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.**—Arnold Challman, for the past four years manager of the company's branch office in Peoria, has been named to the newly created position of administrative assistant in the company's regional sales and service office in Chicago. R. C. Ferguson, formerly manager of Honeywell's district sales office in Davenport, will manage the Peoria branch office while R. R. Scott, former regional sales manager for the company's valve division in Chicago, is the new manager of the Davenport office.

**Neucor, Inc., Pasadena, Calif.**—General expansion of the facilities of Neucor, Inc., electronic instrument manufacturers, and appointment of Jackson Edwards & Co., well-known electronic agents, as sales representatives for Southern California and Arizona, has been announced today by R. J. Barry, President.

**Reliable Instrument Co., Inc., Philadelphia, Pa.**—A new company under the name of Reliable Instrument Co., Inc., with plant and office at 505 N. 8th St., Philadelphia, 23, Pa., will manufacture thermometers, thermostats, kindred instruments.

**Robertshaw-Fulton Controls Co., New York, N. Y.**—Robertshaw-Fulton Controls Co. will be able to double its production of thermostatic controls and ignition devices for gas-heating appliances at its new $3-million Grayson Controls Div. plant, located on the new Long Beach Freeway.

## NEWS OF LABORATORIES

**Chicago Testing Laboratory, Inc., Chicago, Ill.**—Conway C. Burton has joined the staff of the Chicago Testing Laboratory, Inc., with ten years of practical experience in the manufacture and uses of asphalts and road oils in bituminous pavements and highways.

**Foster D. Snell, Inc., New York, N. Y.**—Under the auspices of the Foreign Operations Administration and the U. S. Department of Labor's Bureau of Apprenticeship, Dr. N. R. Kuloor has joined Foster D. Snell, Inc., consulting chemists and engineers, as a trainee chemical engineer.


# THE ENTIRE CONCEPT OF HARDNESS TESTING

## has now been radically changed by the Development of the REFLEX Hardness Testing Machines with CARL ZEISS Projection System

In the performance of Brinell, Vickers, Knoop, Grodzinski tests it is no longer necessary to make microscopic measurements of the indentations.

These indentations are AUTOMATICALLY projected, greatly magnified, by the REFLEX system, on a ground glass screen, right in front of the operator.

This takes less time than applying an initial load, then a major load and returning to the initial load. And the values obtained in the REFLEX machines are very much larger than depth values. Larger values always permit more precise measurements, resulting in more accurate, reliable, informative test data.

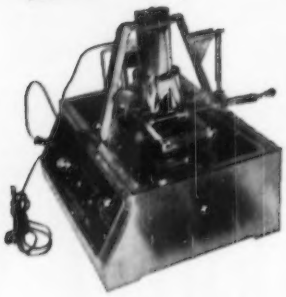
***Write today for your copy of Bulletin No. A-14.***

**GRIES INDUSTRIES, INC.**
Testing Machines Division • New Rochelle 2, N. Y.

**FOR ALL INDUSTRIES**

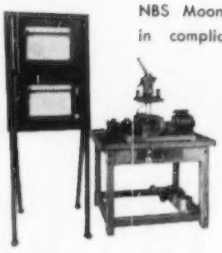
## SCOTT TESTERS* provide authoritative test equipment

### PLASTICS



Model E—manufactured in compliance with ASTM D 746-54 T for brittleness of elastomers at low temperatures.

### RUBBER



NBS Mooney—manufactured in compliance with ASTM D 927 - 53 T for viscosity, and D 1077-49 T for scorch and cure characteristics of rubber and other elastomers.

### TEXTILES

Model J—manufactured in compliance with ASTM D 76 - 53 for general textile tensile testing.

Whatever your need for physical testing of materials or constructions—from single fibre to 1 ton tensile—Scott Testers* are the accepted standard to fulfill the specific test requirements of your industry. We invite you to submit your problems.

*Descriptive literature sent upon request.*

*Trademark

**SCOTT TESTERS, INC.** 120 BLACKSTONE ST., PROVIDENCE, R. I.



# BRITTLE FAILURE—LONG RECOGNIZED, LITTLE UNDERSTOOD

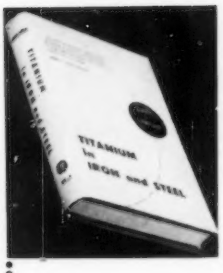
475 illustrated pages of answers will be found in the ASTM cloth-bound volume

SYMPOSIUM ON
EFFECT OF TEMPERATURE
ON THE
BRITTLE BEHAVIOR OF METALS
WITH PARTICULAR REFERENCE
TO LOW TEMPERATURES

Tanker Schenectady split in two at outfitting dock

**American Society for Testing Materials**
1916 Race St., Philadelphia 3, Pa.

$5.65 to ASTM Members
$7.50 to Non-Members



*Ready Now!*

## TITANIUM in IRON and STEEL

By GEORGE F. COMSTOCK, Consultant, Titanium Alloy Division of the National Lead Company

*The third in the Alloys of Iron Research New Monograph Series, Frank T. Sisco, Director*

This is the only book available that reviews and correlates all the important data in world literature on titanium as an alloying element in iron and steel. Nearly 300 references (listed in the bibliography at the end of the book) were reviewed for the manuscript.

Opening with a general discussion of titanium—its principal sources, concentration, preparation, etc.—the book goes on to examine the properties and effects of the element when alloyed with cast iron and steel. Its deoxidizing effects are treated in full. Special emphasis is placed on its unique effects in stabilizing nitrogen and in fixing carbon in alloys where other carbides may be undesirable, and on its usefulness in steel which is to be enameled, and in certain complex ferrous alloys for high-temperature applications.

1955 294 pages Illustrated $6.00

*Send for your ON-APPROVAL copy today.*

JOHN WILEY & SONS, Inc.
440 Fourth Ave. New York 16, N. Y

## LIFETIME ACCURACY

### is built into Taylor etched stem thermometers and hydrometers!

**THERMOMETERS:** A.S.T.M.'s, Plain, Armored or Pocket-Type. Precision-built and designed for maximum readability. Expertly annealed for minimum breakage. Specially aged before pointing and graduating for permanent accuracy.

**HYDROMETERS:** Taylor *Easykleen** Plain and Thermo-Hydrometers are built with the same precision. Streamlined designs assure correct readings, no trapping of bubbles on surfaces. They sink rapidly to floating point.

**SPECIAL DESIGNS** made to order for scientific, research and production purposes. Available with all scales recognized by Bureau of Standards.

**Write for Catalog LH**

Taylor Instrument Companies
Rochester, N.Y. Toronto, Canada

*Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

*Trade-Mark

## *New* "REX" RUBBER HARDNESS GAUGE

**. . . WITH MAXIMUM INDICATOR**

Extra hand stays at full Durometer reading until turned counter-clockwise for resetting

- Measures creep reading
- Accurate to plus or minus one-half Durometer point.
- Complies with ASTM specifications for rubber hardness.

Best for production control. Rugged, reliable. Fully jeweled. No recalibrations. No adjustments. Weight 8 ounces. Individual mahogany case.

WRITE FOR DETAILS

**W. F. ORTH**

800 South Ada Street Chicago 7, Illinois

Export office: 306 W. Washington Street, Chicago 6, Illinois

*Taylor Instruments*
*MEAN*
*ACCURACY FIRST*

IN HOME AND INDUSTRY

*Fertilizer Chemists demand*

**WHATMAN**

*Filter Papers*

Chemists who control the quality of the fertilizers that make possible America's enormous crop production use WHATMAN Filter Papers regularly as do their opposite numbers in government laboratories.

To filter "yellow precipitate" in the determination of phosphorus, No. 7 is the preferred grade while for gravimetric analyses the qualities washed in HCl and HF are employed.

You doubtless use WHATMAN papers also but you may be able to improve your work by consulting our new catalog listing all the grades. A copy is yours for the asking.

**H. REEVE ANGEL & CO., INC.**

*52 Duane Street New York 7, N. Y.*

*All dealers in laboratory supplies carry WHATMAN in stock, order from your regular source of supply.*

WHATMAN High Grade FILTER PAPERS


## INDEX TO ADVERTISERS


AMERICAN MACHINE AND METALS, INC. RIEHLE TESTING MACHINES DIVISION . . . Inside Front Cover
ANGEL & CO., INC., H. REEVE . . . 94
ATLAS ELECTRIC DEVICES CO. . . . 83

BUEHLER, LTD. . . . 77
BURRELL CORP. . . . 90

CENTRAL SCIENTIFIC CO. . . . Inside Back Cover
CUSTOM SCIENTIFIC INSTRUMENTS INC. . . . 83

EASTMAN KODAK CO. . . . 79
EBERBACH CORP. . . . 84
ELECTRO PRODUCTS LABORATORIES . . . 76

FISH-SCHURMAN CORP. . . . 84
FISHER SCIENTIFIC CO. . . . 3
FREED TRANSFORMER CO. INC. . . . 76

GAERTNER SCIENTIFIC CORP. . . . 95
GENERAL RADIO CO. . . . 96
GRIES INDUSTRIES INC. . . . 91

HOGGSON & PETTIS MFG. CO. . . . 88

INSTRON ENGINEERING CORP. . . . 75

KIMBLE GLASS CO. . . . 4
KLETT MANUFACTURING CO. . . . 88

LEITZ, INC., E. . . . 73

MALLINCKRODT CHEMICAL WORKS . . . 85
MEASUREMENTS CORPORATION . . . 81

OLSEN TESTING MACHINE CO., TINIUS . Outside Back Cover
ORTH, W. F. . . . 93

PERKINS & SON, INC., B. F. . . . 76
PRECISION SCIENTIFIC CO. . . . 87

RIEHLE TESTING MACHINES DIVISION, AMERICAN MACHINE AND METALS, INC. . . . Inside Front Cover

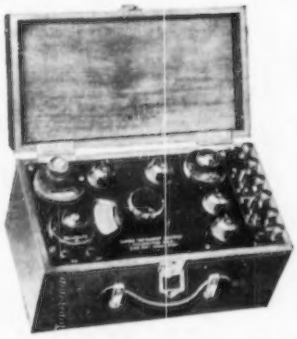
SARGENT & CO., E. H. . . . 73
SCOTT TESTERS INC. . . . 92
SPERRY PRODUCTS CO. . . . 80
SYNTRON CO. . . . 76

TAYLOR INSTRUMENT COS. . . . 93
THOMAS CO., ARTHUR H. . . . 89
THWING-ALBERT INSTRUMENT CO. . . . 95
WILEY & SONS, INC., JOHN . . . 93
WILSON MECHANICAL INSTRUMENT DIV., AMERICAN CHAIN AND CABLE . . . 81

YOUNG TESTING MACHINE CO. . . . 2

PROFESSIONAL CARDS . . . 70, 71

# THWING-ALBERT TREASURE CHEST



The most unique and original pyrometer checking set.

A highly accurate potentiometer and a complete pyrometer and thermocouple testing and calibrating set combined in one portable instrument.

Checks all types and makes of pyrometers.

Range zero to 101 millivolts.

Permits checking while instruments are in service.

The Treasure Chest is self-checking.

Meets every requirement for accuracy, utility and ruggedness.

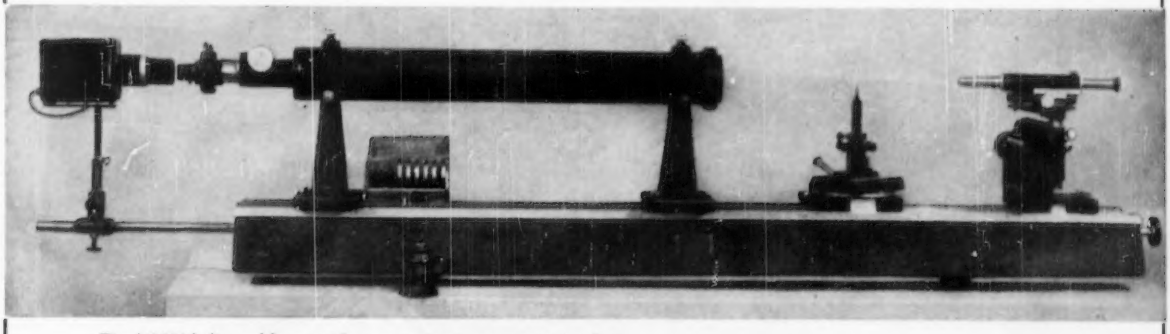
## THWING-ALBERT INSTRUMENT COMPANY

**5339 Pulaski Avenue** **Philadelphia 44, U.S.A.**

126

# Gaertner OPTICAL INSTRUMENTATION

FOR PRECISE ACCURATE MEASUREMENTS OF OPTICAL ELEMENTS OR ASSEMBLIES SPECIFY THE L360N PRECISION OPTICAL BENCH ASSEMBLY



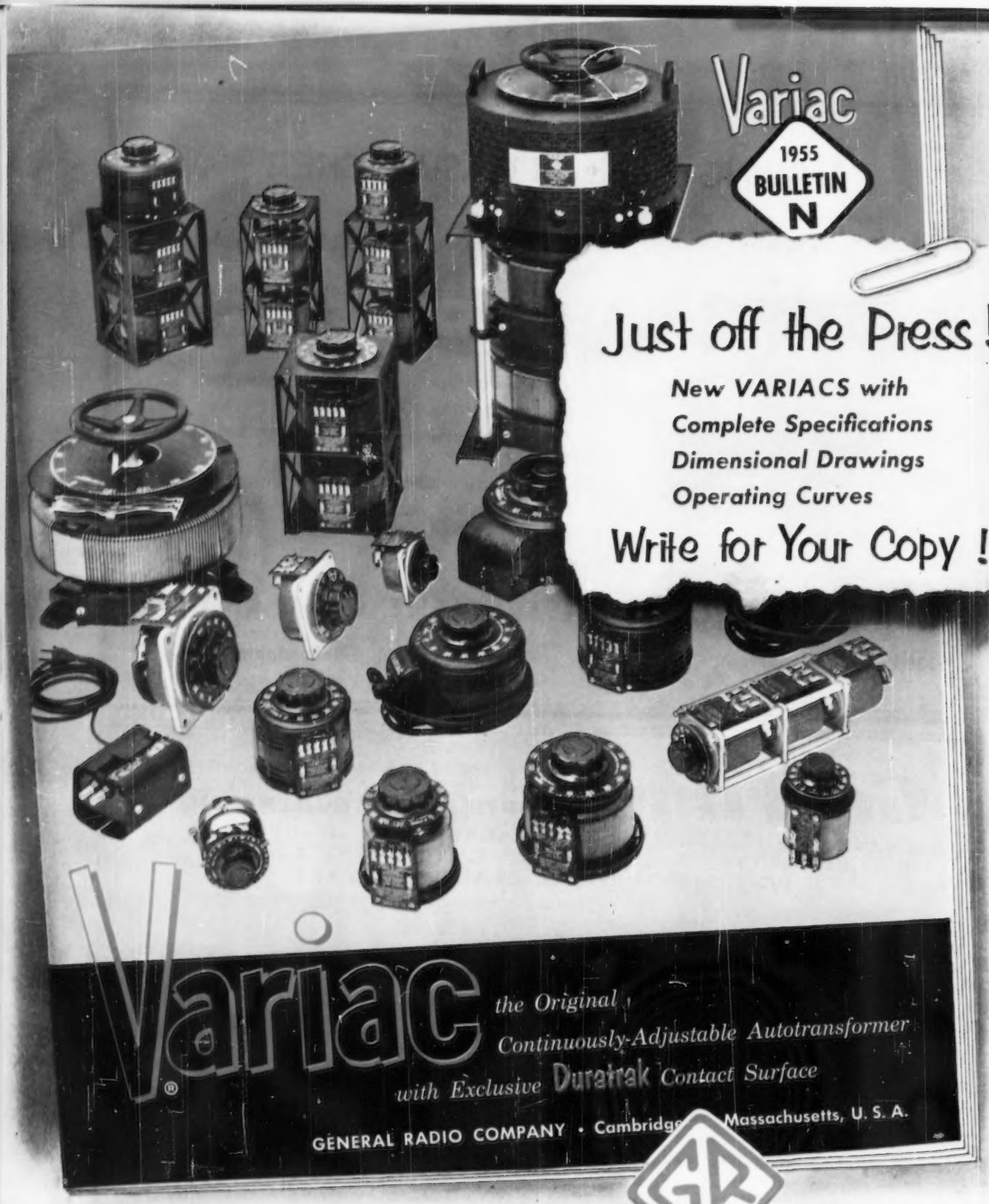
**The L360N Assembly provides convenient measurements of—**

| | | |
|---|---|---|
| DISTORTION | COMA | ASTIGMATISM |
| FOCAL LENGTH | CURVATURE OF FIELD | CHROMATIC ABERRATION |
| RESOLVING POWER | SPHERICAL ABERRATION | (LATERAL AND AXIAL) |

***Complete specifications and details will be found in Bulletin 156-52.***

## THE GAERTNER SCIENTIFIC CORPORATION

1215 WRIGHTWOOD AVENUE • CHICAGO 14 • U.S.A.




# GENERAL RADIO Company

**275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.**

90 West Street NEW YORK 6
8055 13th St., Silver Spring, Md. WASHINGTON, D.C.
920 S. Michigan Avenue CHICAGO 5
1000 N. Seward Street LOS ANGELES 38

602

Please send me the NEW
VARIAC Bulletin 1955 edition

Name _____

Company _____

Street _____

City _____ Zone _____ State _____

# NEW speed...accuracy...dependability...

## in the measurement of percentage hydrogen

## in liquid hydrocarbons

# THE NEW cenco® BETA RAY $^{H}/_{C}$ METER

## utilizes radioisotopes

Here is a practical, efficient precision instrument designed for use in research as well as in product control and routine analysis. It provides a fast, accurate means of measuring the percentage of hydrogen, or the hydrogen-carbon ratio, in liquid hydrocarbons.

- ★ Makes complete determination in 5 minutes
- ★ Accurate to within 0.02 weight percent hydrogen
- ★ Handles hydrocarbons ranging from normal pentane to 1.6-dimethylnaphthalene with no change in precision over the full range
- ★ Calibration is independent of pressure changes in ionization chambers since they share a common supply of gas
- ★ Temperature changes do not affect measurement since both specific gravity and beta absorption measurements are made automatically at same temperature
- ★ Twin beam instrument using single beta ray source is independent of source variations
- ★ Adequate shielding makes instrument safe from radiation hazards
- ★ Null-point balance is independent of electrometer variations

The New Cenco Beta Ray H/C Meter fills a long felt need in numerous petroleum processing operations . . . where the hydrogen-carbon ratio is altered . . . where the percentage of hydrogen is an index to the performance of end products such as jet fuels, fuel oils, gasolines, etc. Our Bulletin No. 115 contains full details about this precision instrument. Write for your copy today.

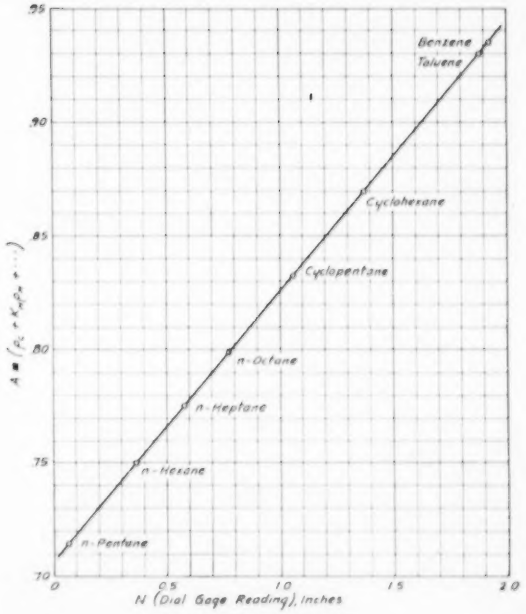



Fig 8. Typical Calibration Curve

*Exclusive manufacturing and sales rights for the Cenco Beta Ray H/C Meter have been assigned to Central Scientific Company by Standard Oil Company (Indiana).*

cenco

The most complete line of scientific instruments and laboratory supplies in the world

R.S.C. TULSA

**CENTRAL SCIENTIFIC COMPANY**

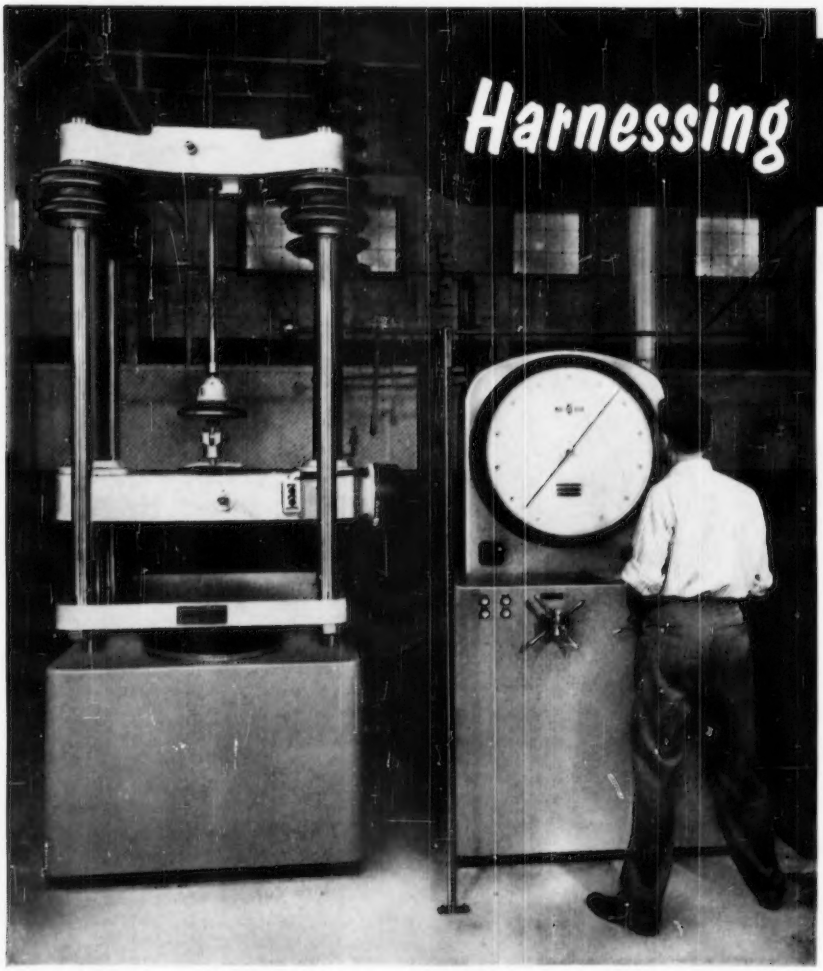
**MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.**
1718-G IRVING PARK ROAD • CHICAGO 13, ILLINOIS

**BRANCHES AND OFFICES** — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES

**CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)**
TORONTO MONTREAL VANCOUVER OTTAWA

**REFINERY SUPPLY COMPANY** — TULSA HOUSTON

City Zone State



# Harnessing Electricity

## ...an example of OLSEN'S Specialized Approach to Unique Testing Problems

Photo courtesy Victor Insulators, Inc

How to test electrical insulators simultaneously for mechanical and insulating efficiency is a problem that was recently given to Olsen testing engineers. The solution: a standard Super "L" universal testing machine with special insulation that permits use of high voltage current with complete safety for both the operator and the machine.

This is just one example of hundreds of unusual testing requirements solved by Olsen using the incomparable Selectrange Indicating System—standard in all Olsen hydraulic Super "L" and electro-mechanical Electromatic testing machines. These industry proved machines are unmatched for testing speed, accuracy, ease of operation, dependability and adaptability.

Given the opportunity, Olsen engineers will take the "special" out of your special testing problem, as well as providing the most efficient and economical machine for your testing needs.

1880 OUR 75th ANNIVERSARY 1955

TINIUS OLSEN TESTING MACHINE CO.
2020 Easton Road · Willow Grove, Pa.
Testing and Balancing Machines